

TPG is a publication of the American Institute of Professional Geologists

# THE PROFESSIONAL GEOLOGIST

VOLUME 60 NUMBER 1

JAN.FEB.MAR 2023

A Month of Arctic Daylight  
Simple Mechanical Analyses to  
Understanding Structural Deformation

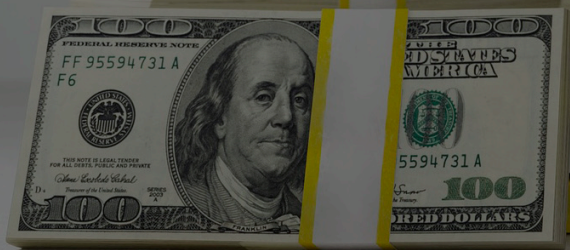
Role of Climate, Rocks, and Soils  
on the Wines of Napa Valley, California





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# THE PROFESSIONAL GEOLOGIST

Volume 60 Number 1

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On the Cover: 2022 Photo Contest Scenic Wonder Winner: Ordesa Valley is a beautiful glacial valley within Parque Nacional de Ordesa y Monte Perdido located in the Pyrenees of northern Spain. The valley walls are a 50- to 250-million-year-old sedimentary sequence composed of carbonates, marl, and sandstone. Waterfalls, lovely streams, and interesting geologic features are common along the Ordesa Valley trail. This area is part of the Sobrarbe Geopark.

Photo taken by: Guy Swenson, CPG-7574, Northeast Section.

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**AIPG Publication Policy, October 4, 2010.** AIPG encourages submission of articles and editorials for publication in *TPG* on topics related to the science and profession of geology. Submittals shall be of interest to the members of AIPG, other professional geologists, and others interested in the earth sciences. Articles and editorials may be noted as follows at the discretion of the Editor, "The opinions, positions and conclusions presented herein are those of the author and do not necessarily reflect the opinions, positions or conclusions of the American Institute of Professional Geologists." All materials submitted for publication, including author opinions contained therein, shall include accurate and appropriate references. The Editor has the authority to solicit, edit, accept, or reject articles and editorials and other written material for publication. The Executive Committee has the authority if it so chooses to act on any particular case to support or overrule actions of the Editor regarding the solicitation, editing, acceptance, or rejection of any particular article, editorial, or other written material for publication.

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The mission of the American Institute of Professional Geologists (AIPG) is to be an effective advocate for the profession of geology and to serve its members through activities and programs that support continuing professional development and promote high standards of ethical conduct.



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# Common Connections

Adam W. Heft, CPG-10265

Happy Holidays! As I write this, the Holiday season is just around the corner; as you read it, it is over or almost over. I hope you all have (or had) a wonderful holiday and look forward to a truly Happy New Year!

The Jan/Feb/Mar edition of *TPG* has traditionally been the Student Edition; however, we have made a change for 2023. The Student Edition will now be the Apr/May/Jun edition, which includes the student scholarship essays. I felt that it made more sense to dedicate this edition to students given the content it already held. Of course, students are welcome to submit articles or opinion pieces for inclusion in **ANY** *TPG* edition...

The deadline for student scholarship essays and student articles is February 1, 2023. One of AIPG's strengths as an organization is supporting geoscience education through scholarships to aspiring geoscientists. The scholarship applications include essays on why students want to become a geoscientist. These writings are inspirational and many relay their love for the outdoors and the earth, influences from teachers, family, and friends, and/or a strong desire to choose a career path that contributes to the betterment of society.

**“Sharing this love of the science, the discoveries, and debating hypotheses about the earth and its processes is fun and brings us together.”**

Many of us have similar stories about why we chose the geosciences as a career for similar reasons. We have this connection as members. We share a love of the science and one of the great things about the geosciences is that they are truly interdisciplinary. **Tom Reynolds, CPG-11186, John Sorrell, CPG-11366, and John Gillentine, CPG-11333** explore the evolution of the profession in this issue and how far the profession has advanced and will continue to evolve into the future.

Sharing this love of the science, the discoveries, and debating hypotheses about the earth and its processes is fun and

brings us together. We don't just talk "shop" with each other either. We connect with family, friends and strangers because the earth and its processes bring us together. **Dr. James Howard, CPG-2536**, has been describing the concept of stealth education and his experiences in lecturing on topics that seem unrelated to the geosciences, yet he weaves geologic information into the discussion. His latest article in this issue is relating common interests and inserting the geosciences through the lectures he gives while on a cruise ship. He offers an effective approach for introducing the topic to the general public and helping them understand processes involved and making them relatable. Jim's cruise ship lectures embody the advocacy of the geosciences profession that is AIPG's mission. And his credentials, both his "Dr." and "CPG" lends the weight of authority to his presentations to the public.

Speaking of talking "shop", in this edition **Gulay Sezerer Kuru, CPG-11912**, takes us to Hafix-Aktas in Turkey to tell us about gold mineralization of ophiolites found there. Minerals and mineralization deposits are the expertise of many of our members. Regular nonmember contributor **Barney Popkin** explains how winemaking in the Napa Valley is influenced and affected by the climate, rocks, and soil found there. Who doesn't love a good glass of wine? Next time you are enjoying one in company, you could share what you've learned about how geology influences the flavor and quality of wine. Each of us works on some project or aspect of the geosciences that are equally fascinating and important. Our members and I would love to hear your experiences and how what you do influences our everyday lives.

In addition to presenting information to the public, some of our long-time members are mentoring our members and students. **Hays Slaughter SA-10132** and **Stephanie Thompson SA-10519** have shared their experiences in AIPG's mentoring program and describe how their involvement with the program landed them both coveted geoscience positions they otherwise would not have had a chance of getting.

Debating hypotheses of ancient geologic events and seeing firsthand modern processes in action is arguably one of the best parts about being a geoscientist. A prime opportunity to see geologic processes in action and learn with other geologists is coming up this summer as we celebrate AIPG's 60th anniversary. **Dr. Tamie Jovanelly, MEM-3396** is leading two 13-day trips to Iceland this summer. She will share her extensive experience and knowledge of the land of fire and ice with the small groups that will accompany her. I'm happy to say that my wife Sara and I are planning to be two of those

*Continued on p. 30*



## GEOSCIENCE UNDER ATTACK – AGAIN

I've always valued and enjoyed reading *The Professional Geologist* (TPG). So, it made me very angry to see ugliness appear inside the October-November-December 2022 issue of the magazine. I am referring to the article titled "Investigating Earth Science Education in the State of Ohio Through Teacher Input." There, at the bottom of page 46 was the logo for the organization URGE (Unlearning Racism in Geoscience).

I had never heard of this organization before. So, I went to the home page and saw pictures of protesters along with placards similar to those found in protests regarding George Floyd and text stating that one of the goals of this group was to remove racism from the geosciences. What?

The text of the article was reasonable as it discussed the issue of installing geoscience and environmental science classes in grade school. However, I thought it was inappropriate to include the logo of URGE and the web address in a reputable publication such as TPG. The name URGE should have been left as a phrase in the text of the article. The organization is clearly nothing more than an anti-American culture which uses racial bullying to get its way.

The geosciences owe nothing to the racial bullying community and no geoscientist should think that they are guilty of some racial miscarriage of behavior. URGE exists to remove everything that geoscientists have created since the first geopick hit an outcrop and the first publication was produced in America. URGE's goals comprise the same attack that has led to historical statues of our founding fathers and heroes being taken down across this country and the changing of the names of buildings which bear their names. It's sickening and wrong!

I, as a white geoscientist, owe nothing to any other individual on the face of the earth except respect and courtesy and just treatment. I do not have "white privilege" – whatever the heck that means. I wasn't born into this world with a silver spoon in my mouth. I have had to work and fight my way forward and "wade into the warring mass that is life" since I was in the second grade. I'm sure many of those individuals reading this letter can empathize with me. I persevered despite many issues - physical, educational, chaotic, personal and of life in general. The only thing I will say is that I did not serve in the Vietnam war, even though my birthday had

a draft number. So, I had a bit of luck there, but that was the extent of it.

The geoscience realm has always been largely white. I'm not sure why and I do not believe anyone has the answer, either. When I sat wells in the Rocky Mountains, the drilling crews were all white. When I sat wells in Texas, the drilling crews were mostly Hispanic or Mexican. I can only guess that the large Hispanic and Mexican population of Texas had something to do with that. As far as college goes, I went to SUNY College at Fredonia in southwestern New York State and Eastern Kentucky University in Richmond, Kentucky. The student populations reflected the ethnic makeup of each local region surrounding the college and the ethnic makeup of each state. The student body in each case was overwhelmingly white. This is nothing to feel guilty about. At least as far as the undergraduate students are concerned (and you know this), individuals are drawn to their local colleges for various reasons. So, why are there not more minorities in the geosciences? Well, minority students gravitate to the same curriculums that white students do. These are computer science, law, business administration, economics, engineering and medicine. These specialties of study are prestigious because they potentially offer greater job prospects and money than the geosciences and, anyway, who ever heard of the geology department.

Small colleges often do not have one. Also, many have been consolidated with geography departments, environmental science departments and physical science departments. Heck!!! Geoscience almost never is included in the STEM curriculum in grade school. So, how is a person who is a minority ever going to come into contact with the geosciences in his or her lifetime? When I was in high school, earth science was offered, but only to those students who did not have plans to go on to college – the stupid students! I was not stupid. So, I did not take this course. One should also consider that powerful psychological factors are also at work regarding whether to major in a particular curriculum or work in a particular company. The thought that "if they do not look like me, they are not for me" is very powerful. I have encountered many white people of various ethnic, religious and social backgrounds who make such decisions on this basis.

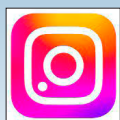
Are the geosciences racist? ABSOLUTELY NOT!!! Do not let anyone or any group tell you so!

**Raphael Ketani, CPG-9003**

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### To the Editor:

I consider the article, "Whatever Happened to the Method of Multiple Working Hypotheses?" in the Oct/Nov/Dec. 2022 issue of TPG to be one of the most valuable articles in years. When I presented my talk, "Top 10 Tips for a Rewarding Geologic Career" to the students and early career professionals at the AIPG Annual Meeting in Marquette, Tip #6 was, "**Be Skeptical.**" That tip dovetails perfectly with MMWH article by Dr. Gooding.

Reading the abstract of the article, I reduced his hypothesis on the reluctance to employ MMWH in scientific research to



the phrase, "Researchers are all too often prisoners of their preferred hypotheses." I have seen vivid examples of this imprisonment over the years, and it is not pretty. While Dr. Gooding does not come right out and say it, there are multiple references in his article to the failure of climate activists to employ MMWH. I agree wholeheartedly, and would even go so far as to assert that most climate activists are openly hostile to the concept of MMWH. Faithful readers of *TPG* will recall that this is a pet peeve of mine.

With a modest effort, it is possible to find much "minority report" information on the internet that offers alternative working hypotheses to the Ruling Theory of Anthropogenic Global Warming. Those alternative hypotheses are ignored or openly scorned by the climate activists. As geologists, we know that Earth's climate is always changing. Milankovitch Cycles appear to be a viable theory for explaining what can be called "mega-changes" of climate (e.g., periodic continental glaciation in the Quaternary with sea level changes measured in hundreds of feet). Shorter-term climate variations appear to be greatly influenced by the periodic variability of solar output. The Maunder Minimum, also known as the "prolonged sunspot minimum," was a period around 1645 to 1715 during which sunspots became exceedingly rare. During a 28-year period (1672–1699) within the minimum, observations revealed fewer than 50 sunspots. This period coincides in the climate record

with the Little Ice Age. At the present time, sunspots and solar flares appear to be at a peak, coinciding with recently observed Northern Hemisphere warming.

Until such time as the climate activists deign to consider MMWH in their analysis, and until they acknowledge periodic warming cycles in the past 11,000 years (some of which make the current "climate catastrophe" look like a cold snap), I will continue to Be Skeptical of the Ruling Theory of Anthropogenic Global Warming.

Peter Dohms, CPG-7141

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Maunder Minimum: [https://www.aanda.org/articles/aa/full\\_html/2015/09/aa26652-15/aa26652-15.html](https://www.aanda.org/articles/aa/full_html/2015/09/aa26652-15/aa26652-15.html)



# Building the Future of Geology Support the Foundation of the AIPG

The Foundation of the AIPG supports a variety of programs including student scholarships, student and young professional workshops, educational programs aimed at practitioners, the public, and policy makers, and some special needs requested by AIPG or other professional organizations. I am excited to begin my tenure as Chairperson of the Foundation. Barbara Murphy has led the effort to reorganize and reestablish the Foundation for the past six years. Her efforts have put the Foundation on solid financial footing and positioned us for further growth. The Foundation is proud to be able to serve AIPG and the geosciences by providing financial support for these programs. Every donation helps the Foundation to contribute toward building the future of geology. If you have any questions or comments about the Foundation, please contact me or any of the other Trustees of the Foundation for additional details and check the AIPG web site for more information about the Foundation. Your continued support is greatly appreciated. Thank you.

*Michael Lawless*, CPG, PG

Chairperson, The Foundation of the AIPG

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*You're Invited!*

# Join the AIPG Ex Com in Tucson, Arizona

AIPG members and their guests are invited to join the National Executive Committee in Tucson, Arizona, during the 2023 Tucson Gem, Mineral & Fossil Showcase events that run between January 28 and February 12, 2023. There will be over 4,000 exhibitors from 42 states and 17 countries at 50 different locations throughout Tucson. The gem show started in 1955 as a local get-together of rockhounds and has grown into a show that is known world-wide and is on the bucket list of most geologists. The gem show season culminates with the Tucson Gem and Mineral Show, which is the largest, oldest, and most prestigious gem and mineral show in the world. The theme for 2023 is "SILICA: Agates and Opals and Quartz, Oh My!"

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During the events, AIPG will hold its First Quarter National Executive Committee meeting on **Saturday, February 4, 2023**, at the Hampton Inn in downtown Tucson (141 South Stone Avenue). This is an all-day meeting starting at 8 am and is open to all members. You can come for the day or just a portion of the meeting. It is a great opportunity to see how your leadership works and learn about the activities being planned. **There will be an online option for members who cannot attend in-person.**

That evening, there will be a dinner starting at 6 pm at El Charro Café (311 N Court Avenue), which is a short walk from the Hampton Inn. The restaurant is the nation's oldest Mexican restaurant in continuous operation by the same family. It was established in 1922 and has a large array of award-winning recipes based on Sonoran and local ingredients.

Please let us know if you will be attending the meeting and/or dinner so that we can save a seat for you. For dinner reservations, please respond by **January 28**.

RSVPs: [https://aipg.org/surveys/?id=Feb\\_2023\\_AIPG\\_Meeting\\_and\\_Dinner](https://aipg.org/surveys/?id=Feb_2023_AIPG_Meeting_and_Dinner)



Scan QR code to RSVP for the meeting and/or dinner in Tucson.



# ***A Month of Arctic Daylight:*** **Research Experience for** **Undergraduates - Program Recap**

**Juliana Gonzalez, SA-11293**

Standing in awe at Zabriskie Point in Death Valley National Park, my phone caught reception for just a second. The world felt grand looking out at that stunning view, but somehow my horizons got a little broader when I saw the notification “you have been added to the group ‘Greenland 2022 Cohort.’”

I don’t recall “confidence” in the list of skills students should expect to gain during an NSF Research Experience for Undergraduates (REU) program. But confidence is a skill, and possibly the skill I practiced most this summer. Last spring, I thought my summer of 2022 would go as follows: attend Field Camp for six weeks, then return home to the beach for what would be my most relaxing summer in years. I did end up at a beach this summer, only it was in a tent on the coast of Sarfanniguit Island, Greenland.

I had never heard of an REU when I came across the Arctic REU Greenland website. The dates for the expedition were timed perfectly with my return from Field Camp, so I took it as a sign to apply. Laboring over application essays until the due date, I didn’t tell anyone what I was working on; frankly, I was embarrassed to think I even had a shot at getting an interview. Well, an interview turned into an invitation, which turned into an unforgettable experience that I can hardly put into words. But I’m going to do my best to express it.

After a series of weekly Zoom meetings, the group (consisting of nine students and two professors) traveled individually from their home states to Albany, New York to quarantine before heading to Greenland. This week was not what I expected from a five day quarantine, which works to my advantage, because I expected a painstakingly bland week in my hotel room. Reading and discussing papers, GIS and safety training, and planning for field work helped the week pass quickly. To kick off the list of new experiences I gained during this REU, the 11 of us loaded onto a bus to board the C-130 flight to Kangerlussuaq. A few days later we flew Air Greenland to Sisimiut (the only airports I have ever been in with only one gate) to embark on the boat ride out to Sarfanniguit Island.

Sarfanniguit gives us the opportunity to study the behavior of earthquakes in the deep crust through exhumed pseudotachylite, which forms from frictional melting on slip surfaces. The first week of field work was spent mapping pseudotachylite in the study area. We became familiarized with the area and began thinking and asking questions now that we’re face to face with the project. This week I learned a lot from both professors and peers; sharing mapping strategies, perfecting our measurement techniques, and even taking a drone out to capture aerial photos of field sites!

During week two, we worked in three groups to study the area on three different scales. One group mapped and described lithology to gain an understanding of lithologic controls on the area. Another group measured pseudotachylite injection veins to study displacement and earthquake propagation direction and

**View of the Davis Strait  
from the campsite.**





magnitude. A third group mapped damage zones in attempts to understand the development of wedge structures we saw throughout the site. We got the opportunity to learn other field skills including the process of choosing what samples to collect and how to properly extract them. Though our field work was split into groups, there was plenty of learning to be done as a cohort. Dividing tasks like filtering water and organizing group gear is just as important as other daily work in the field. Everyone has something to contribute to any group; while one student takes excellent measurements, another is an expert camper, and there really is something to learn from everyone. I learned from more than just my peers, however; Dr. Allen (Concord University) and Dr. Shaw (Montana State University) who led the group are knowledgeable, patient, and more than willing to help us learn as undergraduate researchers, while also letting us ask questions and problem solve independently. I appreciate this team and the friends I've made from all across the country, who helped me make the most of this REU.

Following our return to the U.S, we had the opportunity to work with samples at Montana State University using X-Ray Diffraction and Field Emission Scanning Electron Microscopy. I was part of the team focused on mapping damage zones and interpreting their geometry; we began digitizing maps and cross sections drawn in the field and creating stereo nets to analyze our measurements. We made interpretations on the sequencing of events of how these damaged 'wedges' formed, concluding that they are the result of initial thrusting and aseismic creep, with a pseudotachylite-inducing seismic event following. Each group summarized their findings into a poster presentation for the 2022 GSA Connects meeting in Denver, Colorado.

It's worth noting that watching a Montana summer sunset after a month of constant Arctic daylight is life changing. It's easy to forget how commonly I have access to breathtaking scenery like sunsets, but through this experience I was lucky enough to remember. I often find myself appreciating nature's beauty the most when I'm away from home, and I imagine I'm not the only one. I am grateful for every remarkable destination that this REU has brought me, but also the perspective I have brought home. We sometimes become accustomed to our typical environments and what they have to offer, so I challenge everyone to watch a sunset at home as though it doesn't happen every day.

During these eight months I gained invaluable insight on what aspects of research I enjoy and how I can contribute to a team, which brings me self-assurance as I decide in what direction to steer my future. I love working hands-on, both in the lab and the field, which is important to recognize in the search for graduate programs and jobs.

Sharing ideas in a group, asking questions when I'm confused, and saying yes to new opportunities does not always come naturally to me, but I'm grateful to have gotten practice this summer. Confidence for me does not come from being the smartest and most experienced in a room, it comes from speaking up when I don't know the answer or asking for help from others. I won't do the disservice of not believing in myself again - and my advice to other undergraduates is to chase opportunities that excite you with full confidence.

# Celebrate AIPG's 60<sup>th</sup> Birthday in Iceland!

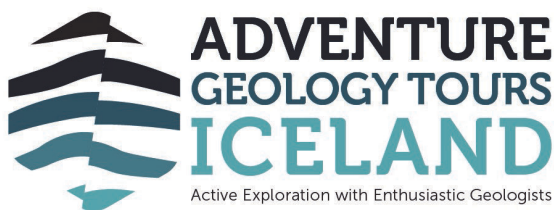
**Tamie Jovanelly, Ph.D., MEM-3396**

My name is Dr. Tamie J. Jovanelly, and I am one of the charismatic owners of Adventure Geology Tours (My husband, Joe Cook, is lucky enough to be my business partner). I define myself as a geologist, professor, best-selling author, international researcher, and adventurer. I have collaborated with AIPG since I became a professor at Berry College (Rome, GA) in 2006. As a solo-geologist teaching an 18-credit hour geology minor alone, the support I received from the Georgia AIPG Section in the form of workshops, lectures, and campus visits allowed my students to quickly rise to the top in the competitive market of environmental consulting. Ultimately, this unique partnership between academics and this professional organization resulted in a win-win situation. That is, AIPG was helping me to develop the actual skill-sets students would need to enter the workforce.

As mentioned, I became a professor in 2006 and immediately began leading Study Abroad trips and conducting international research. While Iceland became my second home, I have also spent a significant amount of time in Italy, East Africa, Costa Rica, India, Brazil, and the Arctic Circle. In 2017, while studying yoga in an ashram in India (and concurrently testing the water quality of the Ganges River), I came to the realization that the thing I loved most about being a professor

was planning the field excursions. And, in doing that for more than a decade, I also realized that I was great at it! Thus, the first rendition of our tour company (Iceland Geology Tours) was born.





Active Exploration with Enthusiastic Geologists

[www.icelandgeologytours.com](http://www.icelandgeologytours.com)

## Tour the land of fire and ice with geologist Dr. Tamie Jovanelly

Geological Society of America Fellow (2021)

Deposit deadline to hold slot:  
DECEMBER 15, 2022



### Trip 1: July 6-18, 2023 | Trip 2: July 25 - August 6, 2023

This 13-day excursion will encompass the entire island focusing on its magnificent geology for \$7,200\* and includes the following:

- 12-night accommodation w/breakfast
- All in-country transportation
- 7 lectures on Iceland geology by a professional geologist
- Geology interpretation at field-sites
- 4 group dinners
- 2 social receptions
- Daily snack and lunch items provided
- Afternoon hot beverages w/local treats
- Signed copy of "Iceland: Tectonics, Volcanics, and Glacial Features"

Also includes paid admission to:

- Blue Lagoon Geothermal Spa
- 3-hour guided hike on Vatnajökull glacier (includes crampon & ice axe)
- Hellisheidi Power Plant
- Fjallsarlón glacial lagoon boat tour
- Lofthellir Lava cave tour
- Lava Center
- Stykkisholmur Water Museum
- Plus a donation to AIPG Scholarship Fund

\*Price does not include air fare, based on double occupancy.  
Minimum number of 10 participants are required to run the trip.

**For more information please contact Dr. Tamie Jovanelly**  
**[info@icelandgeologytours.com](mailto:info@icelandgeologytours.com) or 330-283-9194**

AWG members walking on a glacier.



We launched IGT in December 2019, which corresponded with my book promotional tour (Iceland: Tectonics, Volcanics, and Glacial Features, Wiley, 2020). And, as you are aware, the global pandemic completely shut down all travel plans for the next year. The slow-down, however, provided me with time to grow the company into a full-time career whereby expanding and rebranding into Adventure Geology Tours. Thus, I now get to have all the fun of leading field excursions while still teaching geology, BUT without the headache of having to grade papers.

Our company motto is, "active exploration with enthusiastic geologists". Our trips are thoughtfully curated so that the traveler does not have to worry about logistics once they arrive in-country. Our trips will visit all the famous geology localities and some of those that are off the beaten path. I will do the geology interpretation where appropriate, and then bring in

my in-country colleagues to present their research, or to give a deeper sense of what we are seeing in the field. I keep you busy, but I also intentionally give you time to rest, and space for you to leave the group. I like to keep the size of the groups small; the trips to Iceland are capped at 16 trip participants per tour. Our trips are mostly-inclusive and, unlike large tour operators, our prices include the cost of all excursions and museum entrance fees. Ultimately, my husband and I call it a "tour" instead of a "field trip" because we want the experience to feel more like a vacation. We intentionally build comradery in the group early-on so that great discussions about geology can happen serendipitously. And, speaking of my husband, he is a Nurse Practitioner and can provide medical assistance if needed during our tours.

During Summer 2023, AGT is hosting two affiliated trips to Iceland with AIPG (July 6-18 and July 25-August 6). This will be a great chance for you to travel with a like-minded group of people to a bucket-list destination! You can find out details about each of the trips on our website [www.adventuregeologytours.com](http://www.adventuregeologytours.com). As space is limited, we are starting to collect \$500 refundable deposits to hold slots. If interested, I encourage you to take a look at our 5-star reviews on Trip Advisor (Iceland Geology Tours)! The only thing we can guarantee is that you'll have a great time!





# Simple Mechanical Analyses to Enhance our Understanding of Examples of Structural Deformation –

*What we can learn from these exercises and have fun while we are at it.*

Robert Font, Ph.D., CPG-3953

## Abstract

As students of the earth sciences, we are in a unique position to recognize and describe geologic structural deformations of various scales and magnitudes. Also important is to quantify, as much as possible, the physical and chemical factors and mathematical parameters that explain the observed distortions. In many instances, we can do this by developing quantitative models which allow us to test the accuracy of our theories or, at least, the validity of our assumptions. Two examples are herein presented. The first one describes a submarine gravity slide of substantial proportions in the subsurface of West Texas. The second discusses fault and fracture modeling using an updated version of an elegant old technique.

**Keywords:** Structural deformation, West Texas slide block, fault, and fracture modeling

## The West Texas subsurface slide block

During the years that I worked as a project supervisor for a major oil company in the Delaware Basin of West Texas, I became fascinated by the structural complexity of this region. Starting out as an aulacogen in Late Precambrian to Early Cambrian time, the Delaware Basin is bound on the north by the Northwestern Shelf, on the south by the Ouachita-Marathon Thrust Belt, on the west by the Diablo Platform and on the east by the Central Basin Platform (Figure 1). A discussion of the geologic evolution and history of the area is beyond the scope of this paper, but let it suffice to say that the study of a plethora of well log records and seismic sections has revealed a large variety of structures including faulted anticlines, horst blocks, wrench faults, high-angle reverse faults, normal faults, low-angle thrusts, gravity slides and major unconformities.

A particularly interesting zone of structural intricacy is the area between Coyanosa Field and Rojo Caballos Field on the northeastern side of Pecos County. As one moves from northeast to southwest between these two oil and gas

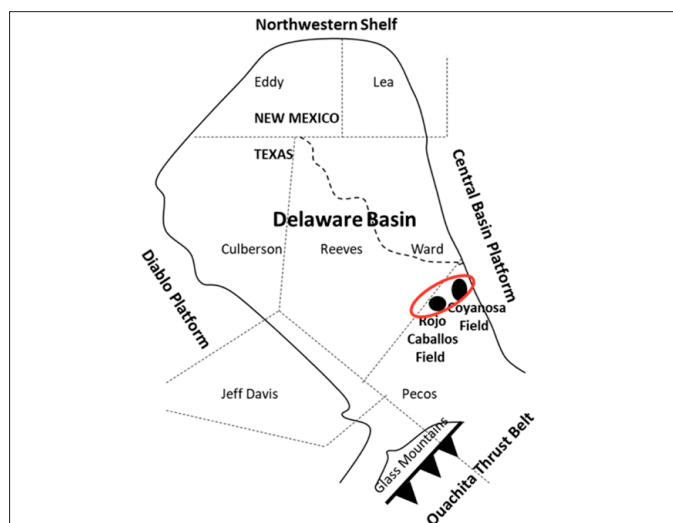


Figure 1. The Delaware Basin of West Texas and the Coyanosa and Rojo Caballos oil and gas fields.

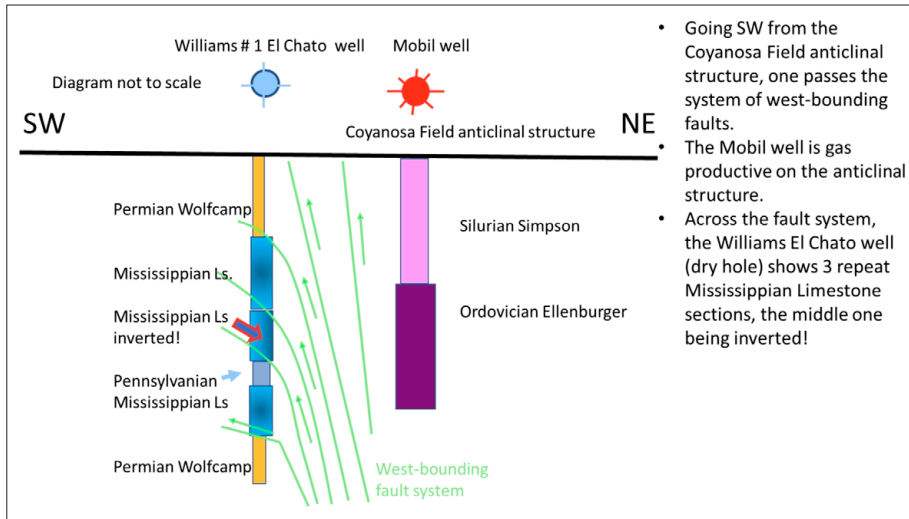


Figure 2. Schematic cross-section crossing the west-bounding faults separating Coyoanosa Field from the Rojo Caballos Field area.

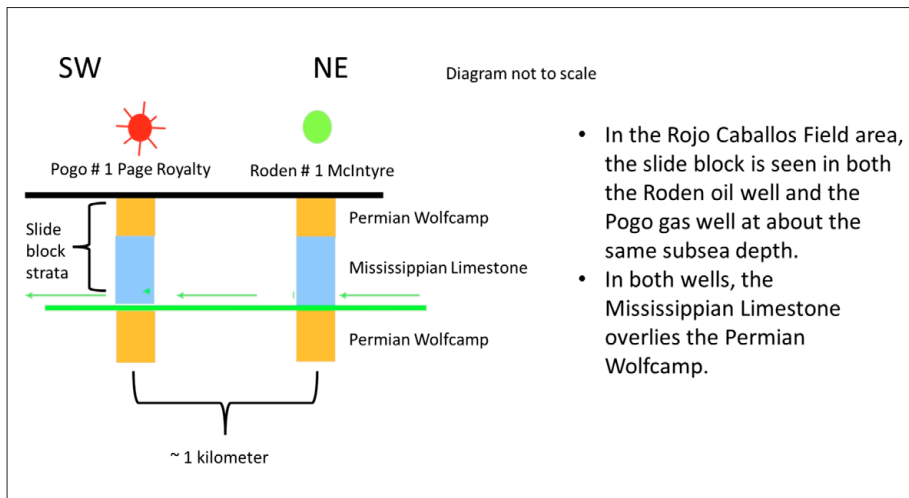


Figure 3. Schematic cross-section illustrating the slide block as seen in the Rojo Caballos Field area.

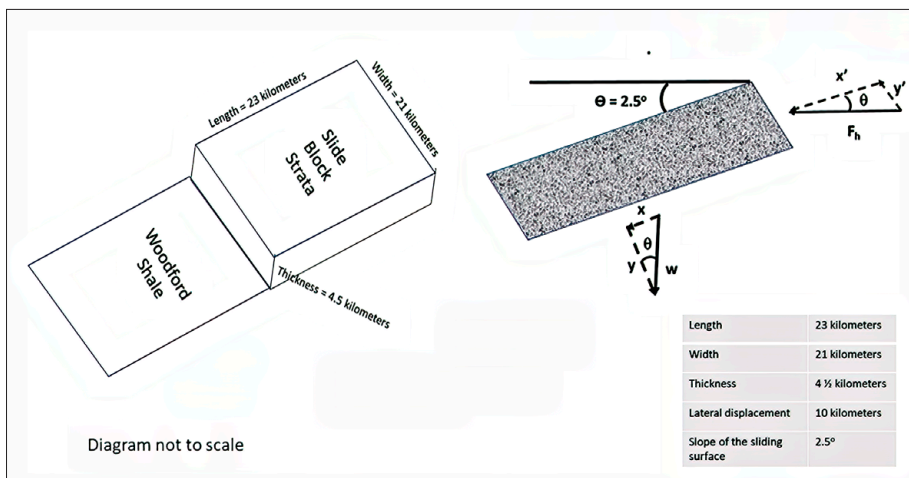


Figure 4. West Texas Slide Block.

fields, we find a large block of Permian, Pennsylvanian and Mississippian strata overlying Permian rocks. West of the west-bounding fault of Coyoanosa Field, the deformation is striking. A series of high-angle reverse faults cut through the Williams #1 El Chato well. As seen in the well log, Permian Wolfcamp clastics are underlain by three repeated sections of Mississippian Limestone; the middle one being inverted. Below the Mississippian strata Wolfcamp rocks are seen again (Figure 2). Further to the southwest in the Rojo Caballos field area, a nearly-horizontal detachment surface separates an upper section of Wolfcamp clastics and Carboniferous strata from the underlying, younger Wolfcamp rocks. This sequence is present in the Roden #1 McIntyre and Pogo #1 Page Royalty wells (Figure 3).

In 1971, Guinan described the detachment and lateral displacement of a large earth block. The deformation mechanism is believed to be one of gravity sliding. Later papers by Pinero, Reaser and Horak (1986) and Hanson and Guinan (1992) further addressed the slide block concept. The authors described a large-scale landslide occurring in Permian (Wolfcamp) time with a volume of 2,173 cubic kilometers and a horizontal displacement of 10 kilometers. According to the authors, the slide bisects Coyoanosa Field and includes all the rock above the Woodford Shale, with the latter defining the actual detachment surface. The base of the slide block is the massive and competent Mississippian Limestone which slid over the Woodford Shale. Thick Permian and Pennsylvanian conglomerates shed from the rising Central Basin Platform to the east coupled with the steepening flexures on the western and southern flanks of Coyoanosa Field gave rise to the gravity slide. The slide dimensions are portrayed in figure 4.

To better understand the deformation related to a gravity slide of this magnitude, a basic mechanical analysis can be performed.

The horizontal stress " $\sigma_h$ " required to move the slide block may be calculated from the equation:

$$\sigma_h = Lpg (\mu - \tan \theta) / 1 + \mu \tan \theta \quad (1)$$

"L" refers to the length of the slide block, "p" is the density of the rocks involved, "g" is the acceleration of



gravity, “ $\mu$ ” is the coefficient of friction along the slip surface and “ $\theta$ ” is the angle of the sloping surface.

Recall that the average crushing strength of sedimentary rocks ranges from 10 to 80 megapascal or  $1 \times 10^8$  to  $8 \times 10^8$  dyne-cm<sup>-2</sup>. Taking the highest number ( $8 \times 10^8$  dyne-cm<sup>-2</sup>) and substituting it for “ $\sigma_h$ ” in equation (1) we can solve for the maximum size block that can be moved “ $L_{\max}$ ”:

$$L_{\max} = (8 \times 10^8)(1 + \mu \tan \theta) / \rho g (\mu - \tan \theta) \quad (2)$$

Inserting into equation (2) the dimensions of the slide block given in figure 2 and using the expected values for “ $\rho$ ”, “ $g$ ” and “ $\mu$ ” of 2.7 g-cm<sup>-3</sup>, 980 cm-sec<sup>-2</sup> and 0.5, respectively, we obtain a value of  $L_{\max} = 6.77$  km.

It is evident that this figure does not explain the observed deformation, as 6.77 km is only about 29% of the size of our slide block. Thus, to move our 23-kilometer-long block a lateral distance of 10 kilometers we must determine the value of the coefficient of friction that would allow it. Rewriting (1) in terms of “ $\mu$ ” and substituting the proper parameters for the slide block into the equation we obtain:

$$\mu = 0.176 \quad (3)$$

Equation (3) forces us to think of the following:

- What overall conditions existed in Wolfcampian (Permian) time along the western edge of the Central Basin Platform that would give rise to a coefficient of friction of this magnitude and cause the detachment of such a large slide block and its movement over a large horizontal distance?
- What was the magnitude of the pore-fluid pressures which developed in the Woodford Shale and what gave rise to these?
- What were the actual dynamics of the movement?
- What event triggered the landslide and what evidence of it may come to light by studying nearby well logs, core and sample data and seismic records?

We should note that a value of  $\mu = 0.176$  compares well to several landslide failures studied in Japan and from mass wasting from the liquefaction of loess (Ling et. al., 2016; Chen et. al., 2008; Peng et. al., 2018). For example, the 1995 Nigawa landslide was induced by the 7.2 magnitude Kobe earthquake involving a volume of  $1.1 \times 10^{-4}$  km<sup>3</sup>. The difference between the Nigawa landslide and our West Texas slide is the volume of rock involved; our slide block being 20 million times larger than the Nigawa slide. In fact, the dimensions of our West Texas slide block are more like those of the massive, submarine Storegga landslide off the coast of Norway which occurred about 8,000 years BP (Bryn et al, 2005; Walker et. al., 2020).

In comparing the West Texas slide block and Norway’s Storegga landslide we can state that both are huge as well as examples of submarine mass wasting. More than likely an earthquake triggered both events. Sediment liquefaction and pore fluid pressure buildup due to the abrupt disassociation of methane hydrates are not hard to envision. Tsunami must have ensued in West Texas, just as it happened along the offshore of Norway. (In the Storegga landslide, tsunami derived sediments are found in Scotland).

In the West Texas slide model, some geological issues also need further reflection. The only high-standing area and potential source of the slide block is the Central Basin platform that lies to the east. However, the Carboniferous strata contained in the slide block is missing from the Central Basin Platform in our critical area. The conventional train of thought is that the strata is absent due to erosion. This is a logical and well-educated deduction on our part, but is the explanation really that simple or are there additional factors for us to consider?

In summary, the calculations resulting from this analysis are fun to make, helped my thinking process and sharpened my visualization of this impressive structural event. They also made me realize that my understanding of the slide block model is less than what I initially thought.

## Fault modeling and fracture prediction – The fun of reviving an old technique

In these days of sophisticated software programs and computer simulations, it is interesting to revisit some of the older quantitative geological models to see if they still apply.

Seventy-one years ago, in 1951, Hafner proposed an elegant method of fault geometry modeling published by the Geological Society of America and subsequently referred to in various structural geology textbooks.

A basic premise asserts that fault patterns can be predicted from the fracture patterns that develop from a common stress field. Our knowledge of fracture geometries is based on field observations, experimental rock deformation and theoretical geomechanics. The fact is that we know that shear fractures occur at angles of approximately 30° to the major principal stress ( $\sigma_1$ ) and 60° to the minor principal stress ( $\sigma_3$ ).

Stress and strain are second order tensor quantities and are related through the theory of elasticity. Stress must satisfy the equations of equilibrium. In similar fashion, strain must satisfy the compatibility equation which ensures that the strains are compatible with and derivable from the displacements. In 2-D the compatibility equation may be written in terms of the normal stresses as:

$$\nabla^2 (\sigma_{xx} + \sigma_{yy}) = 0 \quad (4)$$

In his 1951 paper, Hafner’s brilliance was in using the Airy stress function ( $\Phi$ ) which directly satisfies the equations of equilibrium. The compatibility equation in terms of the Airy stress function becomes:

$$\nabla^2 (\partial^2 \Phi / \partial x^2 + \partial^2 \Phi / \partial y^2) = \nabla^2 \nabla^2 \Phi = \nabla^4 \Phi = 0 \quad (5)$$

Equation (5) is the biharmonic equation and the desired relationship for our fault modeling and fracture prediction analysis. Solutions of the biharmonic equation automatically satisfy stress, strain, and the theory of elasticity. We may obtain these by setting geologically realistic boundary conditions and by selecting mathematically convenient forms of the Airy stress function.

Setting proper boundary conditions constitutes the greatest challenge, since we wish to establish realistic geologic models and not purely mechanical ones. Mathematically convenient forms of the Airy stress function are third-degree and fourth-

degree polynomial functions where some of the coefficients can be arbitrarily assigned.

Hafner did his work before we had gained substantial knowledge from experimental rock deformation. Consequently, Hafner's model can be upgraded by incorporating information from actual rock mechanics tests conducted under various environmental conditions and considering mono-lithologic and multi-lithologic sequences.

Modeled here are a shale, limestone, sandstone, and dolomite within an earth block 8 kilometers long (x) and 3 kilometers thick (y). For each rock type and from data of rock deformation tests performed in the laboratory, I was able to establish an acceptable linear relationship expressing the ultimate strength (US) in kilobar as a function of depth (D) in kilometer, based on normal pressure-temperature gradients and at a strain rate consistent with faulting. We may now assume that when the maximum shear stress ( $T_{max}$ ) exceeds the ultimate strength (US) of a particular rock, it will rupture. Conversely, when  $T_{max}$  is lower than the US, the rock will be stable. The actual plots of ultimate strength versus depth for these rocks are illustrated in figure 5.

To illustrate how this works, for the example presented here, like one of the original Hafner models, the following boundary conditions are superimposed on the standard geostatic stress condition:

- A horizontal tectonic push from the west;  $\sigma_{xx}$  decreases from left to right, varies linearly, and has constant gradient in the horizontal direction.
- A negligible tectonic vertical stress;  $\sigma_{yy} = 0$ .
- A tectonic shear stress  $T_{xy}$  which is constant along horizontal planes and increases vertically at constant rate.

For each x and y value within our 8 km by 3 km block, we can calculate corresponding values for  $T_{max}$  and the angle  $\nabla$ , where  $\nabla$  (in our case) is the angle between the major principal stress and the horizontal. For the shale, sandstone and limestone, the deformation field is displayed in figure 6.

As expected, lithologic complexities affect zones of stability versus fracturing (figure 7). Under an identical stress system, there are distinct differences between a mono-lithologic earth block as compared to a multi-lithologic one. Note how zones

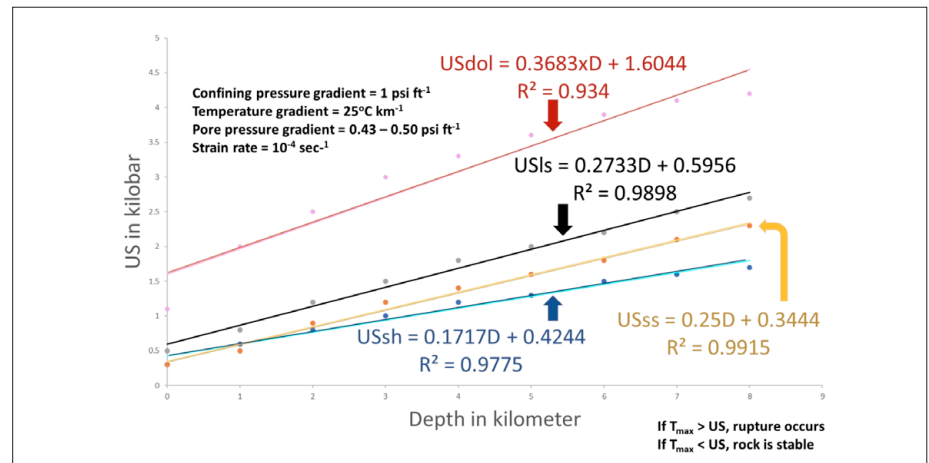


Figure 5. Ultimate strength vs. depth for various rock types tested.

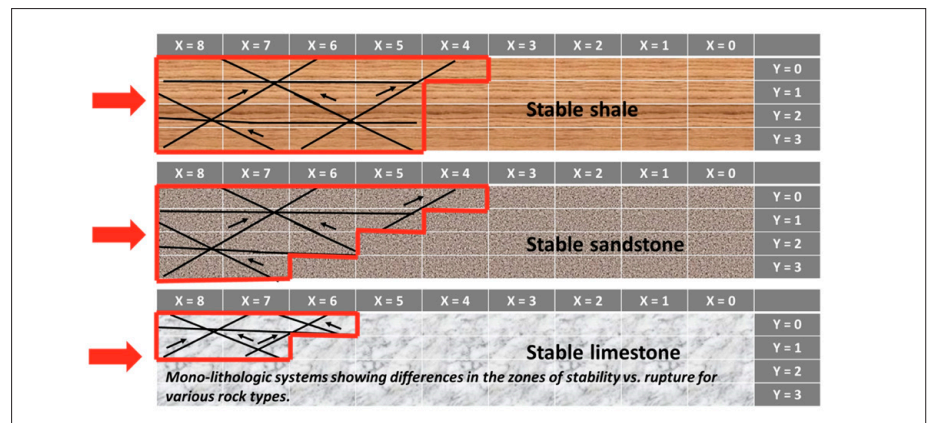


Figure 6. Zone of faulting vs. stability under an identical stress system for mono-lithic models of various rock types within an 8 km x 3 km block.

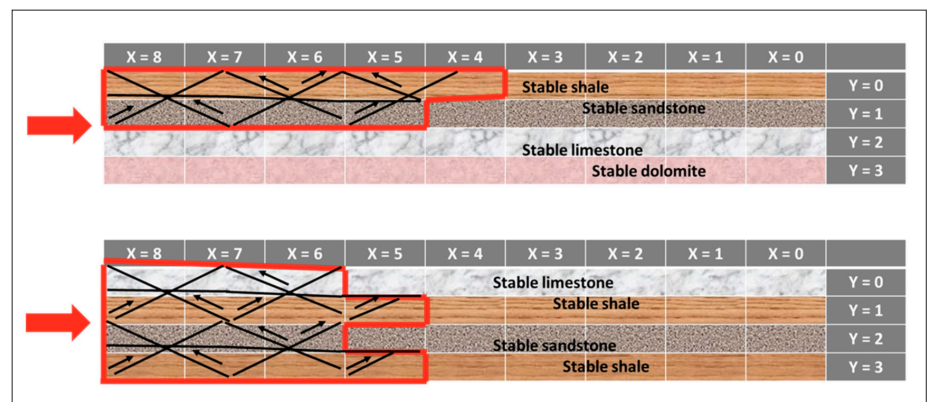


Figure 7. Zone of faulting vs. stability under an identical stress system as a function of lithologic complexity and positioning of competent vs. more ductile strata within an 8 km x 3 km block.

of rupture versus stability are affected by the positioning of the rock units.

Figures 6 and 7 are employed to specifically illustrate the ability of the Hafner technique to predict zones of solidity

*Continued on p. 31*



# Role of Climate, Rocks, and Soils on the Wines of Napa Valley, California

## Part 1 of 2

Barney Paul Popkin

The French concept of “terroir” embodies all the geological, geochemical, pedological, topographic, hydrological and micro-climatic factors that create the environment experienced by a growing vine, vineyard, or part of a vineyard. Climate includes the atmospheric processes influencing water delivery, sunlight and temperature characteristics, and weather patterns at regional scale to the scale of individual vineyards (or even to the microscale of individual rows of grapes). Rocks includes landscape, elevation, slope direction or attitude relevant to the sun (as the sun’s energy is the crop’s water pump and the grape’s ripener), seasonality (as the summer heat and autumn chill impacts the grape), earth history, parent rock and its weathering, erosion, and deposition. Soils are the end products of parent material (rock), climate, organic matter, microorganism activity, and time. Hydrology and drainage are important factors related to both rocks and soils. Although water is the most important factor for plant growth, the quality of the grape crop depends heavily on soil nutrients and trace elements. Soil water availability is most important to transport soil nutrients and trace elements to the plant needed for plant growth and for water to cool the plant by evapotranspiration.

Historically the finest wines came from France, then Germany and Hungary, in part thanks to ideal terroir. Over the past 70 years, refrigeration and other innovations have allowed vintners and winemakers to artificially manipulate conditions to replicate the ideal natural conditions by closer crop spacing in shallow wet soils and further crop spacing in well-drained dry soils in the 1970s in Napa and Sonoma Valleys of northern California (Howell, 2002; Johnson, 2019).

The vineyard manager must integrate and manipulate rootstock variety selection, spacing and irrigation frequency, amount, and duration, with the vineyard’s terroir to achieve optimal plant growth and grape quality. The best strategy is to pair the rootstock with the terroir, rather than artificially modify the terroir to meet the rootstock. Winemakers may therefore separately bottle wine from blocks with differing terroirs rather than blend together the product of the entire vineyard, which might result in a less desirable product.

From the Lerkekåsa Vineyard, at 59.4°N in Norway, to the Bodega Otronía at 45.5°S in Argentine Patagonia, 73 countries in 2014 produced 31 million tons of wine (Wikipedia, 2021) in climates from humid temperate to tropical deserts. The top countries were, in order, Italy, Spain, France, United States, China, Argentina, Chile, Australia, South Africa, Germany,

Portugal, Romania, Greece, Russia, and New Zealand, and they produced over 90% of the total.

Soil thickness and soil water availability are the main factors influencing crop production, including vineyard production (University of California, Davis. Coarse-grained (e.g., sandy or gravelly) soils drain quickly and therefore need more irrigation to assure water to the plant’s rootstock. However, too much irrigation produces more sugar in the fruit and dilutes its flavor intensity. In slowly draining, fine-grained (e.g., clayey or clay loam) soils the plant’s rootstocks need to be more closely spaced and watered less frequently to avoid their roots becoming water-logged.

Water quality is important, with dissolved solids, particular ions, and pH (acidity and alkalinity) being particularly important. Grape growers may treat their irrigation water to adjust acidity or alkalinity, total dissolved solids (TDS), major ions, or trace elements. Vineyard managers may add baking soda to irrigation water or mix wood ash, lime, and crushed limestone into acidic soils to raise their pH. They may mix sulfur or gypsum into alkaline soils to lower alkalinity, and may add nitrogen, phosphorus, potassium, and nutrients to vineyard soil through fertilizers, but they rarely let their soils lie fallow. Growers don’t generally use a nitrogen-fixing cover crop or intercrop their vineyards, but they sometimes use mustard cover to repel insects and control soil erosion. Vineyard managers are very protective of their fields and often adjust field conditions 20 or more times per growing season to ensure successful integrated pest management, good irrigation, and fertilization, or to prune and protect the vines to assure sufficient sunlight and avoid water logging and grape mildew.

One can make drinkable wine from any fruit or sugar-rich plant, but grapes are considered best because of their sugar and acid content, aroma, and visual impacts. What does it take to make “internationally acclaimed” or high-end wines? It takes an artful combination of terroir, which determines the type of wine to make (hence the quote, “Great wine begins with dirt.” (Swinchatt and Howell, 2004)), and cultivation, harvesting, processing, and aging practices (Wilson, 2012; Winemules, 2021). Moreover, even with the right grape varieties, successful winemaking is not guaranteed (Mercer, 2021; WhirrBuzzer, 2021).

Most commercial, manipulated, mass-market wines are not particularly well balanced or natural, as they are manipulated

for volume through blending, yeasts, food additives, flavored, and other interventions. Such wines are often referred to as “faulty wines” by wine experts or connoisseurs. Gourmet, fine, or high-end and connoisseur-acclaimed wines (i.e., “low-intervention wines”) strive to be more balanced and natural but may be mislabeled and misrepresented. Because of its high value, the wine industry attracts universities, researchers, consultants, producers, investors, collectors, and of course customers (Geetarpetals, 2021).

Throughout the world’s commercial wine-producing regions, vintners and agencies have identified and mapped areas of unique terroir and designated them by names such as AVA (American Viticultural Area) for wines produced in the United States and AOC (Appellation d’Origine Contrôlée) for specific standards or AOP (Appellation d’Origine Protégée) for wines produced in France. The Napa Valley has 16 diverse AVAs (Visit Napa Valley, 2021). See Box 1 for Napa’s selected acclaimed wines.

### Box 1. Selected acclaimed wines of the Napa Valley

White wines of Napa include Chardonnay, Sauvignon Blanc, Semillon, Dry Riesling, Sauvignon Vert, Viognier, Chenin Blanc, Chenin Blanc Viognier, Rose, Fumé Blanc, Pinot Gris, Pinot Blanc, Sauvignon Gris, Elevage Blanc, and GALEXY Blanc.

Red wines of Napa include Cabernet Sauvignon, Zinfandel, Cabernet Franc, Merlot, Petit Verdot, Petit Petite, Pinot Noir, Syrah, and Malbec.

Much has changed in wine making over the centuries, especially since the 1970s when aggressive interventionist management began to dominate over the natural qualities of

the terrane. Examples include those included in Box 2 below, and the numbered list above the box:

1. Pure to grafted grape rootstock varieties.
2. Natural grapes to hybrid grapes.
3. Non-interventionist soil fertility, drainage, and acid-alkalinity to fertilization with chemicals, manures, legumes, and clover cover and application of soil amendments to improve or regard drainage and achieve acid-alkalinity balance.
4. Innovations in watering by using treated wastewater<sup>1</sup> or saline water<sup>2</sup> to irrigate vineyards.
5. Pesticides to integrated pest management (IPM) and good agricultural practices (GAP) including pest-resistant rootstocks, soapy water sprays, and beneficial microorganisms.
6. Grape harvest schedule by groundhogs, cosmology, almanacs, and moon cycles to hours of sunlight and grape-sugar test results.
7. Foot stomping to wooden-screw press then hydraulic press, and suction extraction of juice from grapes.
8. Non-interventionist wines to interventionist wines including addition of sugars, yeast, coloring, flavoring, preservatives, and blending of juices.
9. Oak barrel to stainless-steel tank aging of wine.
10. Natural cave or burial to air-conditioned cold storage of wine barrels or tanks.
11. Natural cork to plastic plugged bottles.
12. Management techniques like lowering the shallow

### Box 2. Usage of practice both traditional and current

Usage or Practice	Traditional	Current Practice
Rootstock	Natural Variety	Grafting onto pest-resistant rootstock
Grape variety	Natural	Hybrid
Soil fertility	Inherent	Chemical Fertilizer, legume cover, soil amendment
Soil drainage and pH	Inherent	Grading, soil amendment
Pest control	Pesticides	Integrated Pest Management, Good agricultural practices
Harvest date determined	Almanac	Measured sunlight hours and grape sugar-content
Grape pressing	Hydraulic	Suction extraction of juice from fruit
Fermentation	Natural	Blending, Addition of sugar, yeast, coloring, etc.
Aging	Oaken barrel	Stainless-steel tank

1. At Yavapai College’s Clarkdale, Arizona viticulture and enology program’s onsite vineyard (Gotbrix, pers. comm., March 2021).
2. For example, SARDI-GWRDC, UC Davis, and other (Rohan Prince, pers. comm., February 2021. Note: Treated wastewater is at least 200-500 milligrams per liter (mg/L) more saline than fresh water, but not as salty as “slightly saline” (1,000-3,000 mg/L TDS), or “brackish water” (3,000-10,000 mg/L TDS). The challenges of using salty waters for grape irrigation include chloride and other ion toxicity, salt accumulation in soil, salt leaching into groundwater, salt entering surface waters, and increased soil salinity potential that works against the hydraulic potential for soil-water-root-xylem-leaf uptake.





Figure 1. Napa County's American Viticulture Areas (AVA) showing Valley AVAs and Mountain AVAs (Napa Valley Vintners, 2021. [https://napavintners.com/wines/red\\_wines/napa\\_valley\\_ideal\\_for\\_cabernet.asp](https://napavintners.com/wines/red_wines/napa_valley_ideal_for_cabernet.asp))

water table for clayey valley soils to avoid root rot and water-borne disease by pumping, tile drains, open canals, or closely spaced grape stocks, and implementing more frequent irrigation and fertilization for high permeability sandy and gravelly soils.

According to Carpenter and Cosby (1938), no agriculture was practiced in the Napa Valley prior to the 1836 arrival and settlement of George C. Yount. The first Napa Valley vineyard for wine making was planted in the latter part of the 1850s because it was thought that the soils and climate of the Valley were particularly favorable for growing grapes to make wine. The Valley produced 300,000 gallons of wine and more than 3,000 gallons of brandy in 1870, and nearly 3,000,000 gallons of wine and 60,000 gallons of brandy in 1880 with more than 50 wine cellars. In 1886, the Valley produced 4,500,000 gallons of wine and 102,000 gallons of brandy, when *Phylloxera vastatrix* (PV) began to ravage the vineyards and depress production until PV-resistant rootstocks were aggressively introduced in the 1890s and the vineyards recovered.

The Valley is known for the quality of its wines, and wine making is an important industry, producing 6,000,000 gallons of wine in 1938.

Since Napa's best wines began to win international blind-tasting events in the 1970s, Napa has continued to surprise Europeans by becoming a serious competitor to even the best of their wines.

The Napa AVAs are usually presented as based on unique combinations of micro-climate and elevation. More fundamentally, the bedrock, topography, and soils are key factors. Figure 1 shows the 16 Napa AVAs in a topographic context. Table 1 lists and describes the climate and elevation of the Napa AVAs, their major valley or mountain type, soils and bedrock, and acclaimed wines and characteristics.

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**Table 1. Napa's Mountain and Valley American Viticulture Areas (AVA), soils, bedrock, and acclaimed wines**

Napa's American Viticultural Area (AVA) <sup>1, 2</sup>	Soils and Bedrock <sup>3, 3A, 3B</sup>	Acclaimed Wines <sup>1,3</sup>
<b>1. Atlas Peak:</b> temperatures about 10–15°F cooler than the valley floor in summer, above the fog line, low day-to-night temperature range, summer rarely rise above 90°F; Elev. 760- 2,600 ft.	Volcanic in origin, with basaltic red color, shallow with limited water retention, so irrigation is often essential. <sup>3</sup>	Cabernet Sauvignon, Sangiovese: Bright berry and cherry fruit, and more acidity than wines from Stags Leap District. Chardonnay: Crisp, flora, aromatic, with distinctive pear-mineral flavors and bright acidity. <sup>3</sup>
<b>2. Calistoga:</b> summer diurnal range 40°F>100°F; Elev.300-1,200 ft.	Highest AVAs percentage of volcanic Generally thin, uniform soils on volcanic bedrock. <sup>3A</sup>	Cabernet Sauvignon, Zinfandel, Syrah, Petite Sirah. <sup>1</sup>
<b>3. Chiles Valley:</b> Diurnal range: <59 - mid-80s F with colder winters and spring, as well as strong winds, harvest comes later than on the valley floor; Elev. 600-1,200 ft	Valley floor: primarily alluvial silty-clay soils, with good fertility. Hillsides more clay-loam and stony-clay, mostly marine in origin, with some volcanic outcropping, and less fertility. <sup>3</sup>	Cabernet Sauvignon, Merlot, Cabernet Franc: Cabernets usually reveal a lush yet firm texture with good acidity, firm tannin and distinctive cherry-blackberry flavors. Merlot typically has vibrant black cherry flavors mixed with a touch of cocoa. <sup>3</sup>
<b>4. Coombsville:</b> Cool, with marine winds from the San Pablo Bay as well as the Petaluma Gap to the west, high temperatures rarely exceed 80°F; Elev. Sea level-700 ft.	Area was blanketed by volcanic ash from Mt. George, overlain by coarse alluvium. The gravelly loams and rocky volcanic soils drain easily and the ash sub-soils hold water. <sup>3B</sup>	Pinot Noir, Merlot, Chardonnay. <sup>1</sup>
<b>5. Diamond Mountain:</b> Moderately warm temperatures with less fluctuation than the north Napa Valley floor Summer diurnal range 50–90°F; Elev. 400-2,200 ft.	Residual uplifted soils of volcanic origin, reddish and very fine-grained, gritty in texture. Some soils on weathered sedimentary rocks. <sup>3</sup>	Cabernet Sauvignon, Cabernet Franc: firmly structured, rich and fairly tannic when young, with strong blackcurrant, mineral, and cedary flavors. Good aging potential. Chardonnay: Full-bodied, yet revealing mineral, green apple-peach aromas with fairly firm acidity; less richly textured than valley floor wines. <sup>3</sup>

1. Visit Napa Valley, 2021.

2. Napa Valley Vintners, 2021.

3. Wilkenson, Peggy Burgess, 2009.

3A. Calistoga Wine Growers, Calistoga AVA Facts, 2021.

3B. Coombsville Vintners and Growers, 2017.



**Table 1. Napa's Mountain and Valley American Viticulture Areas (AVA), soils, bedrock, and acclaimed wines (continued)**

Napa's American Viticultural Area (AVA) <sup>1, 2</sup>	Soils and Bedrock <sup>3, 3A,3B</sup>	Acclaimed Wines <sup>1,3</sup>
<b>6. Howell Mountain:</b> Located above the fog line on the eastern side of the valley, the AVA is warmer and drier than other AVAs, more hours of sunshine and little-to-no marine influence; Elev. 600-2,600 feet.	Volcanic, shallow and infertile. Drainage is high, fertility low. <sup>3</sup>	Cabernet Sauvignon, Merlot, Zinfandel: Powerful, firm, blackberry-currant flavors and often richly tannic, with excellent acidity for aging. Chardonnay, Viognier: Sinewy, firm and not as fruity as those of the valley floor, revealing more citrus and stone fruit flavors. <sup>3</sup>
<b>7. Los Carneros:</b> Cool, with marine winds from the San Pablo Bay as well as the Petaluma Gap to W. temps rarely exceed 80°F; Elev. Sea level-700 ft.	Sedimentary based, former seabed, shallow and generally well drained, as well as more acidic, with low fertility. Most have a sandy or sandy-loam texture. <sup>3</sup>	Ageability is a hallmark of Mt. Veeder wines. Cabernet Sauvignon, Merlot, Zinfandel: Low yields give red wines a firm, tannic structure with strong earth-berry aromas and rich, but powerful flavors. Chardonnay: minerally, apple, even citrus flavors with good acidity. <sup>3</sup>
<b>8. Mount Veeder:</b> Cool to moderate, with most vineyards above the fog-line, warmer nights and cooler days than on the valley floor. Summer highs 85°F; Elev. 500-2,600 ft.	Sedimentary based, former seabed, shallow and generally well drained, as well as more acidic, with low fertility. Most have a sandy or sandy-loam texture. <sup>3</sup>	Ageability is a hallmark of Mt. Veeder wines. Cabernet Sauvignon, Merlot, Zinfandel: Low yields give red wines a firm, tannic structure with strong earth-berry aromas and rich, but powerful flavors. Chardonnay: minerally, apple, even citrus flavors with good acidity. <sup>3</sup>
<b>9. Oak Knoll:</b> Moderate to cool, with marine air and fog often remaining until late morning, afternoon breezes frequently occur, maintaining slightly cooler temperatures than up-valley, summer temperatures to 92°F; Elev. Sea level-500 ft.	Large Dry Creek alluvial fan the defining feature of the district. NW area is composed of volcanically derived soils, with stony or gravelly consistency. S and E areas are transitional from gravel to silty clay loam. <sup>3</sup>	Sauvignon Blanc. <sup>1</sup> Merlot and Cabernet Sauvignon: benefit from a longer growing season with slightly cooler temperature, though crop size is typically less than in other AVAs. Elegant style with fruit flavors of cassis, tobacco and spice typical to Bordeaux-style reds. Chardonnay: showcases flavors of crisp apple, mineral notes and tropical fruit with fine acidity. <sup>3</sup>
<b>10. Oakville:</b> Moderately warm, with temperatures commonly in the mid-90s during summer, but affected by night and early morning fog, the east side receives warmer afternoon sun; Elev. Sea level-500 ft.	Sedimentary gravelly alluvial loams on the W side, with more volcanic but heavier soils on the eastern side. Low to moderate fertility, fairly deep, average water retention. <sup>3</sup>	Cabernet Sauvignon, Merlot: Ripe currant and mint flavors, rich texture and full, firm structure tempered by rich fruit. Sauvignon Blanc: Full, steely, yet very fleshy, and not especially crisp. <sup>3</sup>
<b>11. Rutherford:</b> Marginally influenced by early morning fog. Western bench area is cooler, with less late afternoon sun, tempered by afternoon marine winds. Summer highs are mid-90s, with a distinct day-to-night temperature fluctuation; Elev. Sea level-600 ft.	Western benchland is sedimentary, gravelly-sandy and alluvial, with good water retention and moderate fertility. The eastern side has more volcanic soils, moderately deep and more fertile. <sup>3</sup>	Cabernet Sauvignon, Merlot, Cabernet Franc, Zinfandel: This is "Cabernet country." Quite intense cherry and mineral, almost earthy aromas. Flavors are full, ripe, and notably currant with firm, but supple tannins for extended aging. <sup>3</sup>
<b>12. St. Helena:</b> Warm, due to greater protection from western hills, with less fog and wind, the narrowing of the valley floor provides more heat reflection off the hillsides, summer temperatures often peak in the mid-to-high 90s; Elev. 100-700 ft.	S and W borders are more sedimentary, gravel-clay soils, with lower fertility and moderate water retention. N and E soils are volcanic in origin and are deeper and more fertile. <sup>3</sup>	Cabernet Franc, Cabernet Sauvignon, Merlot: Deep, ripe, often jammy flavors, with firm tannins for structure, and appealing aromas of currant and black fruit. Rhône varieties (Syrah, Viognier): Fleshy, supple and slightly earthy. Zinfandel: Blackberry-like, well-structured. <sup>3</sup>
<b>13. Spring Mountain:</b> Cool, mostly above the fog line, providing warmer nights and cooler days than the valley floor; Summer highs 85°F; Elev. 600-2,600 ft.	Sedimentary; weathered sandstone, shale, loamy and friable in texture. Drainage is high, fertility low. <sup>3</sup>	Cabernet Franc, Chardonnay, Zinfandel. <sup>1</sup> Cabernet Sauvignon, Merlot: blackberry-currant flavors and often tannic, with excellent acidity for aging. Chardonnay, Viognier: not as fruity as those of the valley floor, more citrus and stone fruit flavors. <sup>3</sup>

**Table 1. Napa's Mountain and Valley American Viticulture Areas (AVA), soils, bedrock, and acclaimed wines (continued)**

Napa's American Viticultural Area (AVA) <sup>1, 2</sup>	Soils and Bedrock <sup>3, 3A,3B</sup>	Acclaimed Wines <sup>1,3</sup>
<b>14. Stage Leap:</b> Moderately warm with afternoon marine winds, summer temperatures can reach 100°F, but more regularly are in the mid-90s; Elev. Sea level-500 ft.	Volcanic gravel-loams on the floor of the valley, with rocky hillsides, and low to moderate fertility due to hard clay bedrock subsoils at 2 to 6 ft. <sup>3</sup>	Cabernet Sauvignon, Merlot, Sangiovese: lush, velvety textures and fine perfumed cherry and red berry flavors, supported by soft tannins. Chardonnay, Sauvignon Blanc: Round and ripe yet retain excellent citrus and apple flavors. <sup>3</sup>
<b>15. Wild Horse Valley:</b> A warmer area well to the east, but still moderated by both altitude and prevailing winds coming off Suisun Bay; Elev. 600-1,900 ft.	Volcanic soils, with basaltic red color, shallow with limited water retention, so irrigation is often essential. <sup>3</sup>	Pinot Noir. <sup>1</sup> Cabernet Sauvignon, Sangiovese: Bright berry and cherry fruit, more acidity than District 14. Chardonnay: Crisp, flora, aromatic, with distinctive pear-mineral flavors and bright acidity. <sup>3</sup>
<b>16. Yountville:</b> marine influence, fog, Cool summer mornings, warm afternoons summer range mid-50s-90°F. Elev.20-200 ft.	Gravelly silt loams, sedimentary in origin, and gravelly alluvial soils with rock, moderately fertile. <sup>3</sup>	Cabernet Sauvignon, Merlot: Yountville favors Cabernet and Merlot with ripe, violet aromas and rich, but supple flavors and firm tannins. <sup>3</sup>

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## Annex 1. Estimated values of hydraulic conductivity, porosity, specific yield, and specific retention in selected soils

Soil Type	Hydraulic Conductivity, ft/day	Porosity, % by volume	Specific yield, % by volume	Specific retention, % by volume
Loam		55	40	15
Clay	0.0000008-0.0008	50	2	48
Silt, Loess	0.002-10			
Silty sand	0.2-80			
Fine to coarse clean sand	1-1,000			
Sand		25	22	3
Gravel	2,000-15,000	20	19	1

From Heath (2004).

## Annex 2. Summary and description of features of major Napa Valley vineyard soil series

Vineyard Soil Series and Description	Drainage	Slope %	Landscape and Elevation, ft	Permeability	Parent Material	Water Capacity, in.
1. Aiken, thin acid loam	Well	2-50	Upland soil; 300-2,500	Moderate to slow	Basic volcanic rocks: basalt and andesite	6.5-11
2. Bale, thick acid loam	Poor	0-5	Alluvial fans, flood plains and low terraces; 100-300	Moderate	Rhyolite and basalt	6-9
3. Clear Lake, thick clay or clay loam	Poor	0-2	Old alluvial fans and basins; 20-250	Slow	Sedimentary rocks	8-10
4. Cole, silt loam	Poor	0-5	Alluvial fans and flood plains; 100-300	Moderately slow	Alluvium from sandstone, shale, and basic rock	10-12
5. Coombs, thick, acid gravelly loam and clay loam	Well	0-5	Terraces; 100-500	Moderately slow	Mixed alluvium derived from igneous and sedimentary rocks	6-10
6. Cortina, thick gravelly loam	Excessive	0-5	Flood plains and alluvial fans; 100-500	Rapid	Recent stratified alluvium	
7. Haire, acid loam	Moderately well	0-30	Old terraces and alluvial fans; 20-300	Very slow	Alluvium from sedimentary rocks	
8. Perkins, acid gravelly loam	Well	2-9	Terraces; 150-1,500	Slow	Alluvium from igneous rocks	7.5-8.5
9. Pleasanton, acid loam	Well	0-5	Alluvial fans; 50-600	Moderately slow	Alluvium from sedimentary rocks	8-9
10. Tehama, acidic silty loam	Well	0-5	Alluvial fans and terraces	Slow	Alluvium from sandstone and shale	10-12
11. Yolo, thick, neutral loam and silt loam	Well	0-5	Alluvial fans	Moderate	Recent alluvium	0-12

Adapted from Carpenter and Cosby, 1938; Lambert and Kashiwagi, 1978.

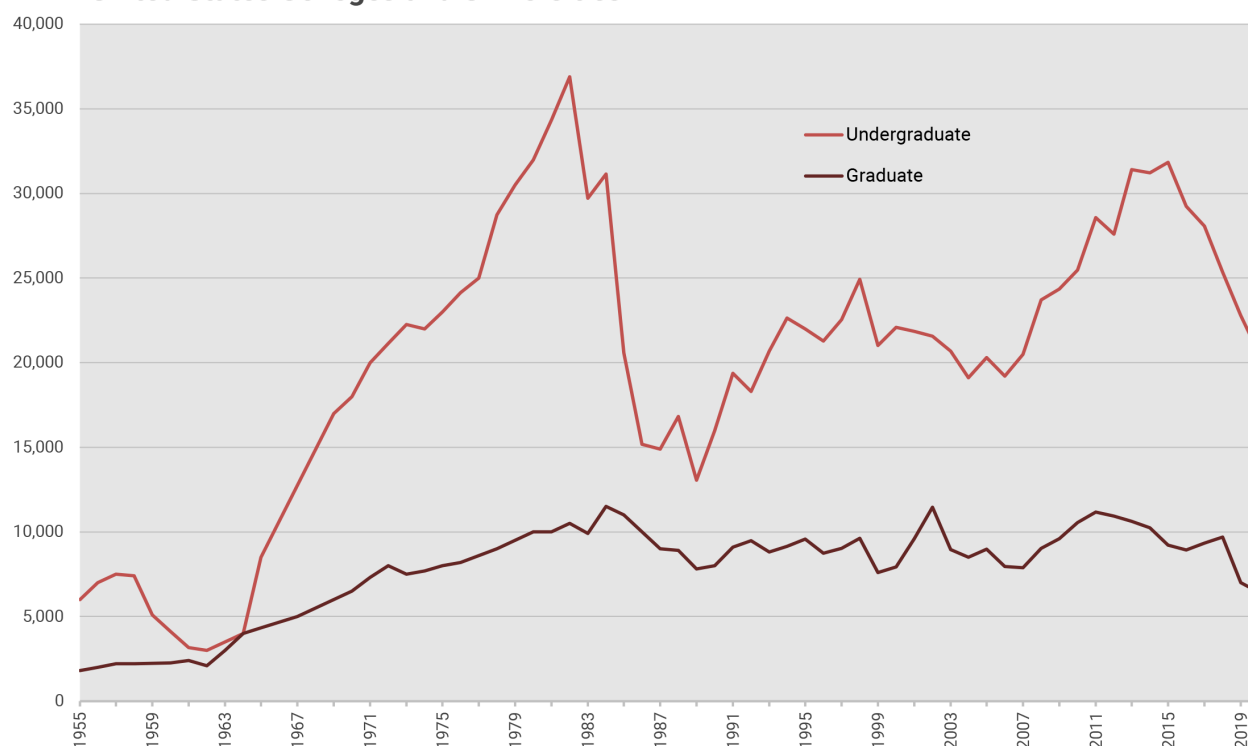


## Geoscience Enrollment and Degrees Continue to Decline through 2021

Geoscience programs in the United States continued to see declines in the number of enrolled students and degrees being awarded through the 2021-22 academic year. The pandemic has exacerbated ongoing negative pressure on enrollments from softening of the oil and gas industry, and now those impacts are seen in degrees granted across all degree levels.

### Enrollment in U.S. Higher Education Geoscience Programs

#### Geoscience Student Enrollment 1955-2021 United States Colleges and Universities



Credit: American Geosciences Institute

Enrollments in U.S. geoscience programs at both the undergraduate and graduate levels have declined for the last several years. The drop in undergraduate majors was initially driven by a combination of a decline in students using the degree as a gateway to work in the shale oil and gas industry as that sector softened along with an increase in the number of online-only geoscience programs for which identifying majors has proven difficult. More recent declines in undergraduate and graduate geoscience enrollments have been driven by the pandemic and an overall drop in undergraduate enrollments across higher education. Of particular note is the first substantive drop in graduate enrollments since 1980, which was driven by the pandemic through a combination of graduate programs declining to admit new students and general uncertainty among students about employment prospects and post-graduate plans during the pandemic. The long-term post-pandemic enrollment trajectories for both undergraduate and graduate majors is likely to become evident by 2024.





# Implementing Stealth Education in the Geosciences - Riding the Waves

## Part 4

Dr. James F. Howard, CPG-2536

As defined in previous articles in this series, Stealth Education is the practice of inserting aspects of the geosciences into topics normally considered as non-geoscience related by emphasizing their role as *causative or influential elements in human physical or cultural development or interaction*.

If possible, a good Q & A session should be worked into the presentation. That can often lead into additional topics that may pique the interest of the audience. As an example, in a lecture on Coral Reef Ecosystems, I introduced the concept of sea level rise and fall due to glaciation cycles and climate change. After the presentation to a cruise ship audience, some of the audience approached the Cruise Director (my immediate ship contact) requesting a separate lecture on Climate Change, Causes and Effects. This provided an excellent opportunity for much greater expansion into the dynamics of the earth system and its interaction with climate cycles.

To best implement the concept of Stealth Education, the topics involved should be chosen to be as diverse as possible and able to effectively blend the topic with appropriate aspects of interest to a general audience. The example selected for the next set of editorials, Alternative Energy Sources, is a current topic and one that can be utilized in many different venues and involve numerous audience types.

Traditionally, when a geoscientist discusses Energy Resources, it is assumed that he or she will emphasize fossil energy sources, such as coal or petroleum or, possibly, nuclear power, depending on the character of the audience. Although these topics do provide excellent avenues for introducing geoscience principles to an audience, potential subjects of more widespread and controversial interest involve alternative energy sources and methods of implementation.

Non-hydrocarbon based energy production is generally divided into several categories, each of which provide ample opportunity to expand into the diverse areas of the geosciences. The primary categories can be assigned as follows:

1. Hydropower;
2. Geothermal (both low temperature and high temperature);
3. Wind and solar power; and
4. Renewables conversion (Hydrogen, biofuels, biomass waste, etc.)

The present editorial will concentrate on the various alternatives associated with hydropower, a major element in both present and past alternative energy programs. It is always useful to introduce basic principles of a subject to an audience with limited experience in the field. For that reason, I assume a somewhat limited educational base, usually around high-school or early college education for the audience background. As such, it is especially useful to introduce animations, particularly GIF or MP4 figures or videos in various parts of the program.

You should always keep in mind that many, if not most, members of the audience (remember your target is the general public) are unfamiliar with the basics of any given aspect of your program. As such, I have found that many excellent sources of visuals are available on websites dedicated to secondary educational teaching, support audiovisual websites or, in some cases, governmental or private information websites.

It has always been of interest to me that the vast majority of people accept the use of a particular product, particularly energy, without understanding any of the elements necessary to produce and deliver the energy to their equipment. For that reason, I would recommend a brief introduction to the subject by means of slides that illustrate the basic principles of electrical energy production.

The primary purpose of most commercial energy generation processes involves the conversion of mechanical energy, provided by some natural source, to electrical energy that can be transmitted to areas utilizing that energy for various activities. Figure 1 illustrates the basic principle behind the conversion of mechanical energy from some natural source to electrical energy. This resultant energy can then be distributed over great distances to locations remote from the generating point.

Figure 1 illustrates the generation of electrical current. Since the magnetic field is in a single configuration, it will produce Direct Current (DC). The generation of Alternating Current (AC) is accomplished by cyclic reversal of the magnetic field. Virtually all methods of generating electricity by conversion of hydropower utilize this concept, with water flow providing the rotational energy necessary for producing transportable electrical energy.

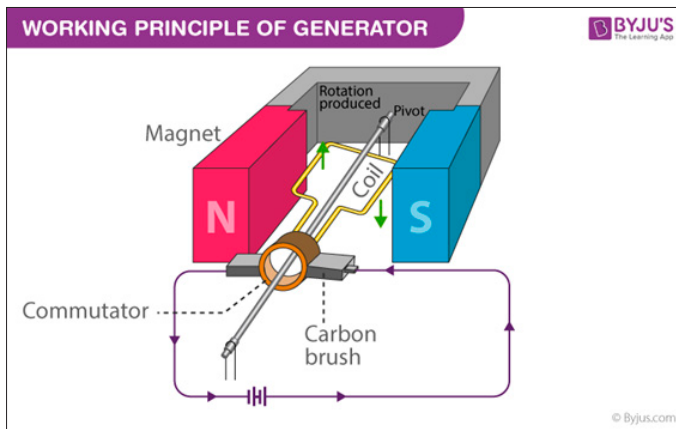


Figure 1. Working Principle of Electricity Generation –Website - BYJU'S The Learning App.  
(This figure is available in animated version.)

There are too many areas of alternative energy sources to cover in one discussion. Therefore, I will try to provide short summaries of the major potential sources in separate discussions that provide multiple opportunities for expansion into basic geoscience principles.

This editorial emphasizes water-based power generation methodologies and some of the vehicles that can serve as points of expansion into associated areas of the earth science spectrum. These include alternative uses of hydroelectric power generation (including traditional impoundment structures/dams), tidal power, in-stream flow, and wave energy.

As hydropower in its various aspects is the oldest of the alternative energy sources of interest today, a discussion should begin with an introduction to the Hydrologic Cycle, a system that controls the availability and the flow characteristics that allow the production of electrical energy.

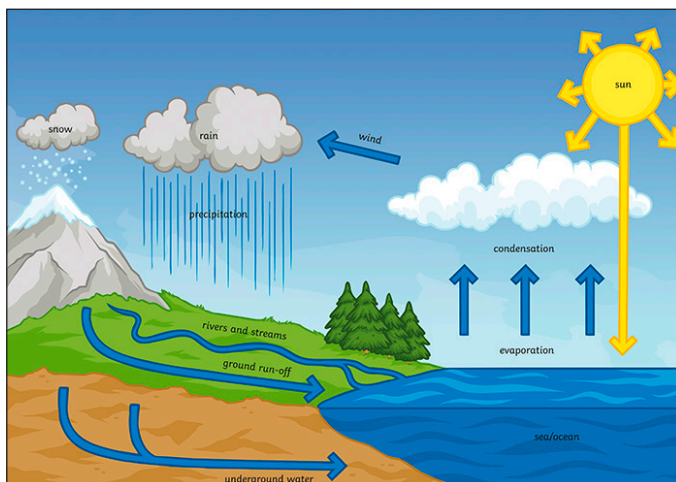


Figure 2. Water cycle vector illustration. A labeled earth hydrologic process explanation diagram with environmental circulation scheme with rain and snow precipitation, cloud condensation, evaporation, and runoff collection. 123RF website.

Each hydropower technology involves the conversion of mechanical energy (provided by fluid flow) into electrical energy that can then be distributed by means of an electrical

grid. The general approaches to the use of water movement in this process are shown in Figure 3.

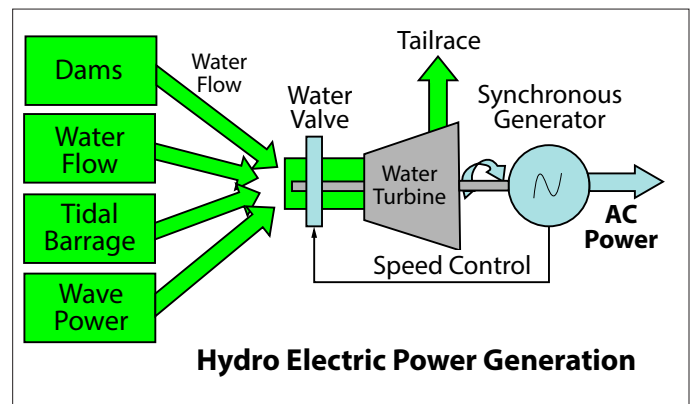


Figure 3. Basic components of Hydroelectric power generation - Battery and Energy Technologies- Electropedia - International Electrotechnical Commission.

For most audiences that are the target of the Stealth Education program, the use of simple GIF animations or short videos illustrating the mechanics of a process will be quite useful. Since animations are not possible in TPG, I will suggest several potential sources for animated versions which can be incorporated into your presentations if you feel they would be appropriate.

The first and most widely used method of converting the energy in water flow to electrical energy is, of course, the use of impoundments to increase the head and consequently the potential energy of a stream. Figure 4 illustrates the basic process by which this conversion is implemented.

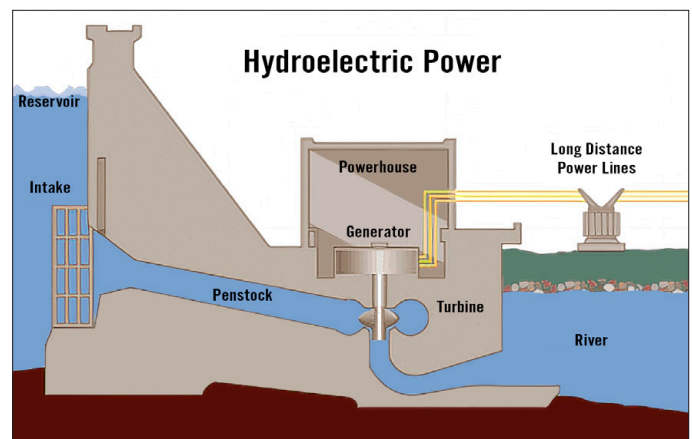


Figure 4. Power from Dams; Battery and Energy Technologies- Electropedia. International Electrotechnical Commission

Introduction of various aspects of the geosciences into this scenario is very simple. I have found that the most effective approach is to discuss the various limitations and ancillary requirements for impoundments. This discussion easily allows the introduction of the hydrologic cycle, sediment transport and the characteristics of stream sediment movement, particularly as they impact sediment accumulation behind



the impoundment and the consequent potential impacts of necessary periodic flushing on ecosystems downstream of the dam, impact of the reduction of sediment flow to any receiving body downstream, e.g. beach replenishment, and enhanced erosion due to impact of detritus released by the flushing process.

This also provides an excellent entree to discuss impacts of fluctuation in the regional hydrologic cycle e.g., the present status of the Colorado River and Grand Coulee Dam water levels as well as the California and western states water supply depletion. Wherever possible, relate the discussion to a local or well-known regional situation to increase the attention span of the audience.

Other major areas of interest in the development of water-based energy alternatives involve the use of naturally flowing streams that allow the conversion of the potential energy in the water stream into electrical energy without the necessity of impoundments which can negatively impact the environment. Several naturally-occurring systems easily fulfill the requirements for large-scale conversion of the potential energy of flowing water into electrical energy, including instream river turbines, wave motion and tidal currents.

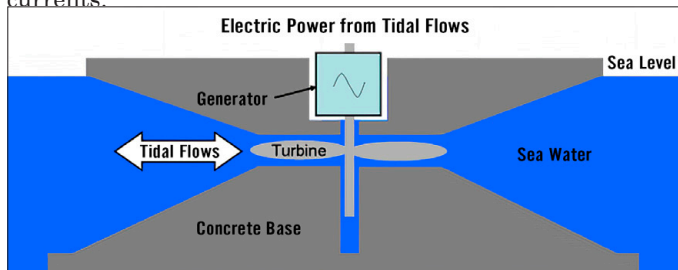


Figure 5. Electric Power from Tidal Flows, Battery and Energy Technologies- Electropedia, International Electrotechnical Commission.

Utilizing the energy of tidal currents has been recognized as a highly cost-effective methodology for this process. Figure 5 illustrates the basic elements of this particular technology.

The use of tidal currents to produce energy is traditionally associated with engineered structures that utilize both flood and ebb tidal flow. There are certain special site location requirements that are necessary for cost-effective implementation of this methodology, as described in a 2014 University of Strathclyde webpage presentation of the MSc Sustainable energy project at the Off-shore Renewable Energy Program.

These site requirements include:

- 2-3m/s maximum spring peak current
- Minimum depth of 15m to seabed at lowest astronomical tide to provide space for the device as close to the coast as possible to minimize transmission costs

These criteria mean that channels and constrictions between two land masses provide the best site because of the resultant faster flow velocities. Large headlands that do not interfere with the flow, estuaries, and narrow entrances to lakes can also be suitable sites.

From cursory examination of these criteria, it becomes rapidly obvious that glaciated coastlines would be prime potential locations for Tidal Energy generation. This provides an excellent opportunity to introduce the concept of glaciation, glacial features (fiords), glacial moraine deposits, coastal geomorphology, tidal origins, and diurnal/seasonal variability in tidal ranges as related to solar phenomena and coastal configuration.

Obtaining energy from wave action is another source of potential alternative energy production. Figures 6 and 7 illustrate two potentially viable approaches to the subject.

Figure 6 illustrates the use of vertical movement of individual waves to power the generator while Figure 7 illustrates the use of channelizing wave action to fill a permanent reservoir or lagoon and provide a constant flow to the turbine generator.

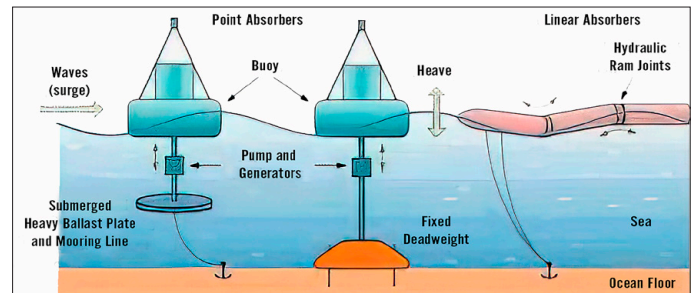


Figure 6. Generation of wave energy through vertical oscillation of float arrays - Barbarelli, S.; Nastasi, B, 2021.

One real advantage of this technology is the potential for technology transfer to other portions of the hydrologic cycle. As shown in Figure 8, the use of instream turbines greatly expands the potential applicability to any stream with

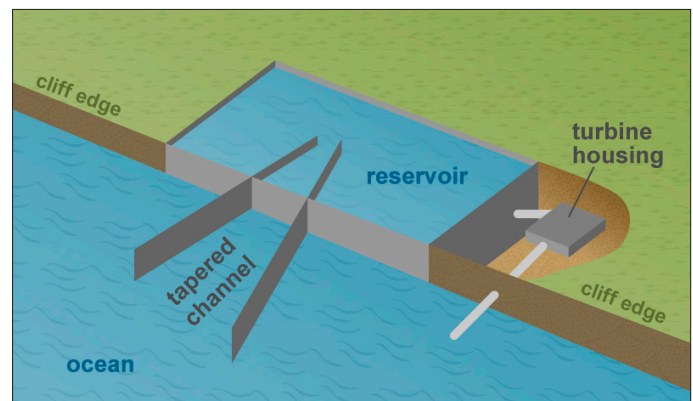


Figure 7. US Energy Information Center – Hydropower explained, 2022.

sufficient flow velocity and illustrates one design configuration of an instream generator that is suitable for use in both tidal and channelized stream flow regimes.

Figure 9 illustrates the flexibility of instream generators that can operate in any flowing body of water from river systems to, in this case, an irrigation canal.

Any discussion on this subject offers opportunities for introduction of additional topics on wave propagation and its relationship to coastal geomorphology, causes of tidal flow

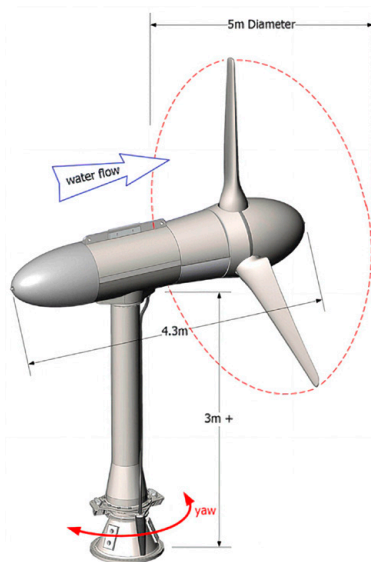


Figure 8. Instream turbine generator  
- Van Zwieten et al, 2007.

are multiple other available sources, I have found that these sites are among the most productive in terms of diversity and quality of product.



Figure 9. Instream current generator in irrigation channel -  
Instream Technology Systems Web Page.

1. IRIS- Incorporated Research Institutions for Seismology
2. US Geological Survey
3. University of California, Santa Barbara Educational Multimedia Visualization Center

Slides, animated and otherwise, are also available on Facebook either prepared by teachers, educational institutions, government agencies or by contracting companies involved in the design and implementation of the technology.

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Barbarelli, S.; Nastasi, B., 2021- Tides and Tidal Currents— Guidelines for Site and Energy Resource Assessment. *Energies* 2021, 14, 6123. <https://doi.org/10.3390>.

and its diurnal character, coastal geomorphology controls on tidal ranges, hydrologic controls on stream flow velocity, stream channel morphology, sediment load and depositional controls, beach replenishment and longshore transport, as well as potential impacts on ecosystems related to the implementation of the various hydropower alternatives.

Some potential sources of animations and videos suitable for various presentations are listed below. Although there

Basic components of Hydroelectric power generation - Battery and Energy Technologies- Electropedia International Electrotechnical Commission.

Power from Dams; Battery and Energy Technologies - Electropedia. International Electrotechnical Commission.

Electric Power from Tidal Flows, Battery and Energy Technologies - Electropedia, International Electrotechnical Commission.

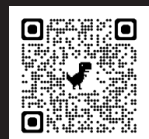
James VanZwieten; William McAnally, F.ASCE; Jameel Ahmad, M.ASCE; Trey Davis, M.ASCE; James Martin, F.ASCE; Mark Bevelhimer; Allison Cribbs; Renee Lippert; Thomas Hudon, A.M.ASCE; and Matthew Trudeau – Instream Hydrokinetic Power: Review and Appraisal|Journal of Energy Engineering|Vol. 141, Number 3, 2007.

United States Energy Information Center.

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# Evolution of the Profession

Tom Reynolds, CPG-11186, John Sorrell, CPG-11366, and John Gillentine, CPG-11333

It's almost a truism to say that geology as a science has grown and changed a lot throughout its history. Starting as a field science, conceptually describing and explaining those parts of the earth which could be seen with the naked eye, it expanded its range to include the interior of the earth and the oceans, using high tech instrumentation, math, and physics. It also grew to include more precise, quantitative study of the origins of the earth and other planets through geochemistry, astronomy, and planetary science. Thus, geology as a science grew steadily more complex and multi-disciplinary.

Learning to understand the earth has grown more complicated, as have the applications of geology. As human society has grown, so have its needs, in both size and variety. The number, types, and quantities of earth materials geologists search for has grown. But the act of searching for and producing those earth materials requires increasing precision and care to minimize damage to the earth. Likewise, the use of those raw materials requires more care, as in facilitating construction through understanding its natural setting.

Given this increasing rate of scientific and professional change, and debate over those changes, it is more important than ever for geologists to keep the "big picture" in mind, and constantly maintain and update their professional skills. Ideally, this should begin while the individual is still in college. Fortunately, the resources to do so are readily available. Now, perhaps more than ever, geologists can keep track of and personally evaluate changes in the subject and tools and implementation of those tools.

For example, geologic literature from different periods in the history of the science often demonstrates different, sometimes confusingly different, approaches to the science. History of Geology is an established academic discipline dedicated to mapping and understanding the significance of those changes in the "big picture". But there are also numerous resources

“Given this increasing rate of scientific and professional change, and debate over those changes, it is more important than ever for geologists to keep the “big picture” in mind, and constantly maintain and update their professional skills.”

outside academia, including popular books like *“Memoirs of an Unrepentant Field Geologist”*, by Francis Pettijohn, *“The Incomplete Guide to the Art of Discovery”*, by Jack Oliver, and *“From Stone to Star”*, by Claude Allegre.

Today's geologists need to learn to be multi-disciplinary in terms of understanding both qualitative and quantitative geologic methods, and in knowing how to communicate with other disciplines outside geology. There again, resources to do that independently are available. Numerous “amateur” books on engineering exist, for example, such as the books by Samuel Florman. Stephen Ressler is another engineer who writes for interested amateurs. It is not necessary to be a fully trained professional to know a subject well enough to be able to cooperate effectively with others on multi-disciplinary teams.

Recognizing, understanding, and evaluating how the profession is changing over time is an important part of geologic training. Fortunately, resources exist for professionals to do that independently, with a minimum expenditure of time and expense.

# Silica-carbonate (listwanite) Alteration of the Serpentinitized Güneş Ophiolite in Hafik-Aktas, Turkey

Gülay Sezerer Kuru<sup>a\*</sup>, CPG-11912 and Ruth Bektas Woodcock<sup>b</sup>

## Abstract

Sivas is located in Turkey's most important precious metal (gold and silver) and nickel mineralization province. The Sivas-Hafik gold and silver mineralization is located in the north of Hafik District and south of Aktas Village. The study area is divided into eight mineralization zones (MZ) including Toptaş-Kırmızıtaş, Keklik Çukuru, Gelin Tepesi, Çatalkaya, Hüseyin Ağılı, Başyurt, Yozyatağı, and Kızıl Tarla. Phase I silica-carbonate (listwanite) occurs in the upper zone of Güneş Ophiolite, and Phase II silica-carbonate (listwanite) occurs in the lower zone of Güneş Ophiolite along with the formation of laterite. Phase I silica-carbonates are composed of principally dolomite and ankerite, rarely siderite, and calcite, magnesite, and serpentinite. Nickel values increase, whereas gold and silver values decrease. Phase II silica-carbonates are commonly composed of silica and have less carbonate material. In contrast to Phase I, nickel values decrease, whereas gold and silver values increase.

**Keywords:** Silica carbonate, Listwanite, Gold, Silver, Nickel, Serpentinite.

## Introduction

The study area is located approximately 50 km east of Sivas and encompasses an area of approximately 2,256 hectares. It is approximately 35 km south of the Hafik District and approximately 1.5-5 km south of Aktas village. Sivas is located in Turkey's most important precious metal (gold and-silver) and nickel mineralization province. Traces of the African and Eurasian plate collision in the Upper Cretaceous is observed throughout the numerous suture zones in Turkey. One of the ophiolite complexes is the Güneş Ophiolite in the Divriği (Sivas) region, which consists of ultramafic rocks, metamorphic rocks, and calc-silicate units. The serpentinitized Güneş Ophiolite ultramafic rocks have high MgO (average 31.3%) and low Al<sub>2</sub>O<sub>3</sub> (average 0.56%) values. The Güneş Ophiolite preserves areas of partial melting traces that possibly occurred within the subduction zone or during obduction processes.

## Regional Geology

Basement rock units of this study area are the Tekelidağ Melange with the Refahiye Ophiolite, and Güneş Ophiolite that settled in the region at the end of the Late Cretaceous in the north. Tertiary units observed in the region and covering large areas begin with the Çerpaçindere Formation, consisting of late Maestrichtian-Palaeocene Tecer limestone and marine clastics located on the Güneş Ophiolite. The Eocene units in the region are the Gülandere Formation with volcanic intercalations, Middle-Late Eocene Doğanşar Formation represented by Köseadağ syenite, the Middle-Late Eocene Doğanşar Formation, which unconformably overlies the ophiolitic mélangé in the north Bozbel Formation, which is olistostromal and blocky, Diştaş agglomerate and Söğütlü conglomerate in the South. These formations overlie Late Eocene-Early Oligocene Küçüküzhisar gypsum and are continuous with Early-Middle Miocene Selimiye Formation, then

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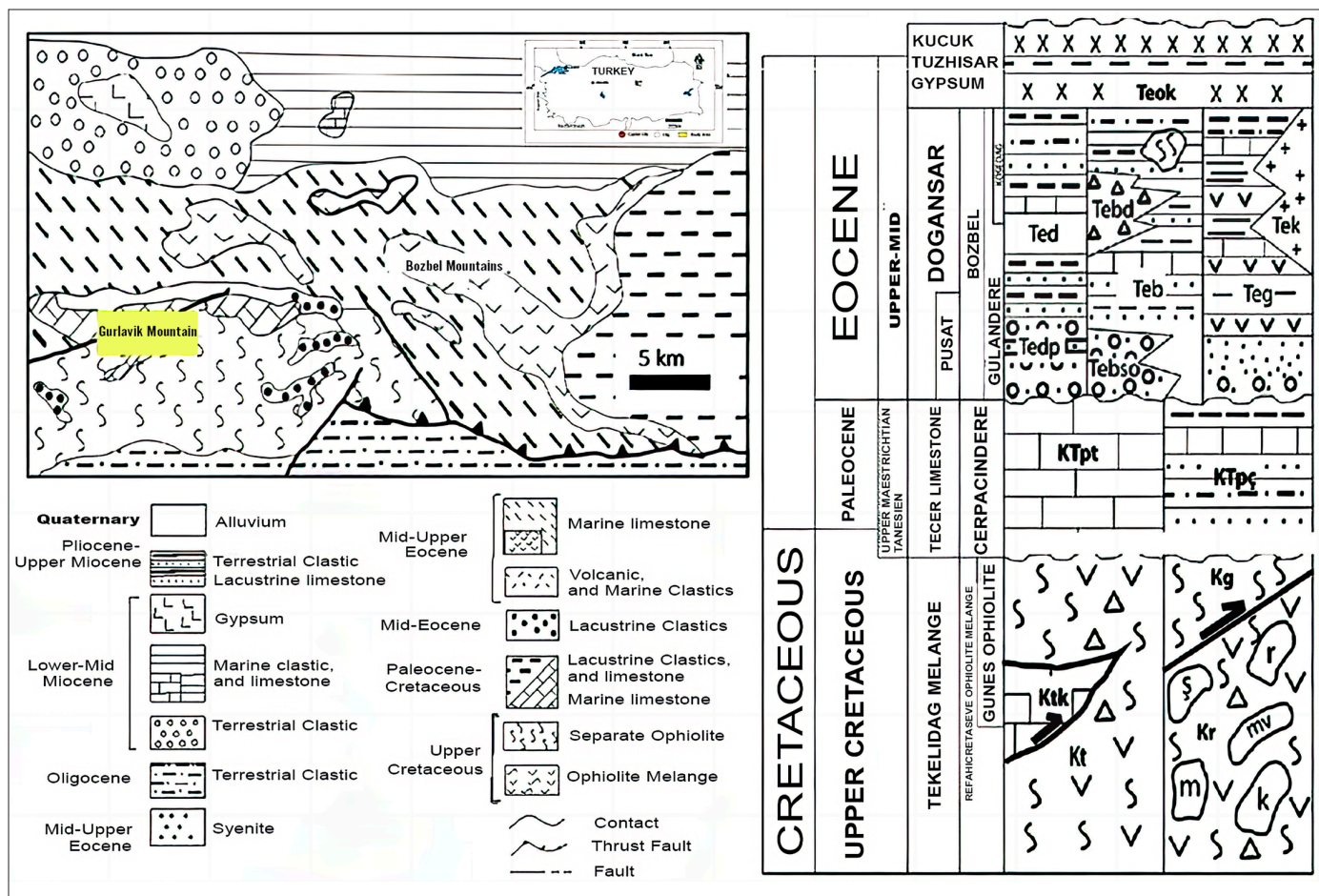


Figure 1. General geology of study area (revised from Bilgiç, 2016).

Celalli Formation, Hacıali Formation and İncesu Formation and Quaternary sediments (Bilgiç, 2016), (Figure 1).

## Ore Geology

The Güneş Ophiolite, which covers a significant part of the study area, and the Kızıldağ (Sivas) Ophiolite of Refahiye Ophiolite Complex has been compared by various authors (Figure 2). All these ophiolitic zones are composed of serpentinized dunite and harzburgite, wherlites, gabbro, pyroxene

gabbro, hornblende gabbro; microgabbro, meta-basalt and spilitic basalts; these are cut by andesite and basalt, aplite, granite, quartz monzonite and diorite which are products of Neogene age magma activity. Nickel enrichment concentrations of 4,630 ppm has been determined and some ore minerals such as linnaeite, bravoite, gersdorffite, millerite, heazlewoodite and pentlandite are also present.

The listwanite phases are identified as Phase I silica-carbonates, and Phase II silica-carbonates in this study area.

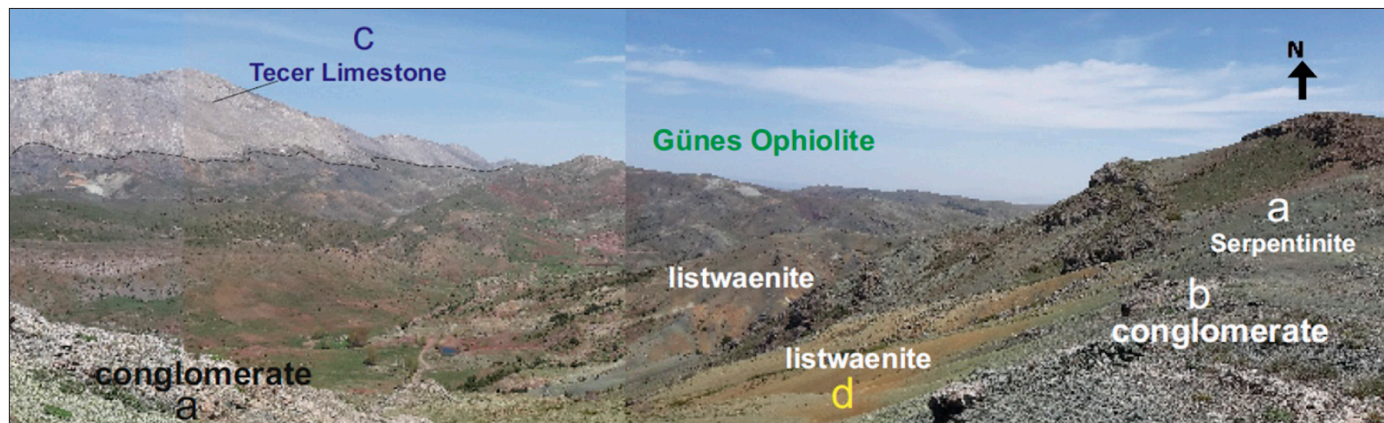


Figure 2. Relationship between Güneş and Tecer Limestone a) serpentinized peridotites, b) conglomerate-listwanite, c) Tecer Limestone.



Phase II is observed more commonly than Phase I. Phase I silica-carbonates are characterized by carbonates, principally dolomite, ankerite, dolomite, and rarely siderite, calcite, magnesite, and serpentinite, talc-carbonate schist, low ratios of MgO, low silica concentrations, high concentration of CaO and CO<sub>3</sub> in the form of carbonate minerals, with increasing Ni and As, while Au decreases in serpentinite. Phase I silica-carbonates (listwanite) are overlain by Phase II silica-carbonate (listwanite). Phase II silica-carbonates (listwanite) are characterized by silica-carbonates, with high silica content in the

form of quartz, chalcedony and rarely opal. Carbonate minerals are either minor constituents or totally absent (Auclair et al., 1993). Phase II listwanite typically includes economical gold deposits with low nickel concentrations. The relationships of Phase I and Phase II listwanites are shown in Figure 3.

## Conclusions

Gold, silver, and nickel minerals were observed in the Güneş Ophiolite. It has been observed that the Güneş Ophiolite is cut by younger acidic magmatic veins which do not belong to the



Figure 3. A. Relationship between Phase I silica-carbonate, and Phase II silica-carbonate (listwanites) in the various regions of the Güneş Ophiolite. B. the Çatalkaya MZ (1) Phase II, and (2) Phase I. C. Phase I (yellowish), and dominantly Phase II silica-carbonate (listwanite) in the Çatalkaya section. D and E. Phase II silica-carbonate alteration of Güneş Ophiolite in Gelin Hill, and Çatalkaya MZ. F and G. Gossanous boxwork texture in listwanite.



Güneş Ophiolite rock units, but they have been very effective in gold and silver enrichments in the Güneş Ophiolite.

Phase I silica-carbonates (listwanite) are composed of varying proportions of carbonates, principally dolomite, ankerite dolomite, and rarely siderite, calcite, magnesite and serpentine. Nickel concentrations increase (maximum 3,175 ppm), and gold and silver concentrations decrease in Phase I silica-carbonates (listwanite) zones. Phase II silica-carbonates (listwanite) are commonly composed of the silica minerals with minor carbonate mineralization. Nickel concentrations decrease while gold (0.005-13 ppm) and silver (5-39.71 ppm) concentrations increase in Phase II silica-carbonates (listwanite) zones. Phase I silica-carbonates (listwanites) are older than Phase II silica-carbonates (listwanites) in all of the MZ. We have observed gold, silver, and nickel mineralization zones extending horizontally 6 to 7 km and vertically from 4 to 5 km within the Güneş Ophiolite. These mineralized zones (i.e., listwanites) are the result of low-sulfidation epithermal solutions and are fault controlled.

Based on the geochemical studies of silica-carbonates from the ophiolite units in the Aktaş Village in Hafik District, Turkey, we suggest that these silica-carbonates (listwanites) are similar in style to carbonatized ultramafic rocks containing economic grades of gold principally within sulphide-rich zones and late quartz veins.

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*Editor's Corner, continued from p.3*

attendees, and we are really looking forward to seeing the fantastic geology and experiencing it in a completely new place. Additional field trip details are in this edition.

For the past year, we've run the Member Photo Challenge. In each of the four categories, "Scenic Wonder", "Geologic Disaster", "Geologists in Action", and "Environmental Impact" we had entries. I'm pleased to share the results of the Photo Challenge. The winner of the Scenic Wonder category is **Guy Swenson, CPG-07574**, and the runner-up is **Ben Chorn, MEM-2866**. The winner of the Geologic Disaster category is **David Abbott, CPG-04570**, and the runner-up is **Mary Moran, CPG-05079**. The winner of the Geologists in Action category is **Albert Lamarre, CPG-06798**, and the runner-up is **Molly Gardner, CPG-12105**. The winner of the Environmental Impact category is **Donovan Vitale, SA-11158**; there was no runner-up submittal for this category. The winner of each category will have their photograph on the cover of *TPG*. Congratulations to each of the winners!

For the past 60 years, AIPG has been the largest association dedicated to promoting geology as a profession. We certify professionals on the principles of competency, integrity, and ethics. Our profession is continuously evolving and changing, just like the earth processes we study. Let's keep the advocacy going, promote connections amongst our geoscientist colleagues, and maintain our standing as credible experts for another 60 years and beyond!

## Photo Challenge Runner-Up: Scenic Wonder Category (right)

### Ben Chorn, MEM-2866, Minnesota Section

Cliffs of Moher. This photo taken while on vacation in Ireland of the Cliffs of Moher. The sandstone, siltstone, and shale layers were deposited in a sedimentary basin during the Carboniferous Period.



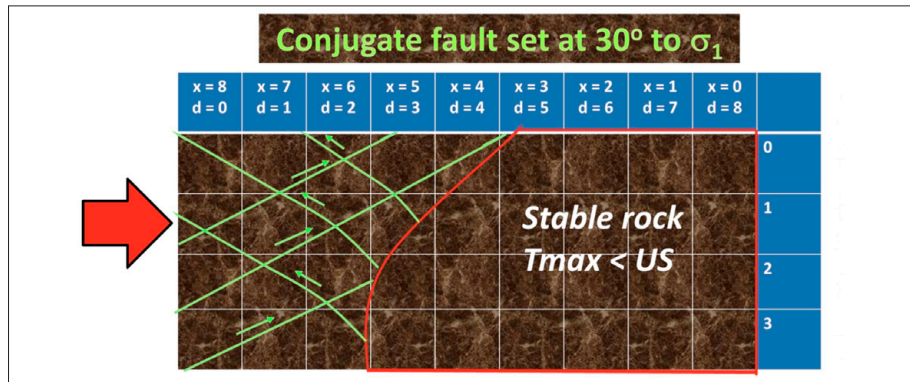


Figure 8. Fault geometry for a given stress system illustrating the development of a conjugate set of reverse faults, where one set steepens with depth and the other flattens with depth.

versus fracture. However, another advantage of the Hafner method is its capacity to forecast actual fault geometry. In figure 8, a clay-shale is shown where the set of stress conditions leads to the development of a conjugate set of reverse faults where one set steepens and the other flattens with depth. Lithologic heterogeneity can also play a role in fault geometry patterns.

In summary, in fault and fracture prediction and modeling adjusting boundary conditions, environmental parameters and lithologic properties and morphology will yield varying results. Our task is to find what best describes the deformations that we encounter in the field. A certain degree of trial and error may be necessary to achieve the objective. Revitalizing the old Hafner model is fun and may help our understanding of the stress systems responsible for the fault patterns that we encounter in our work.

## Conclusion

As one who has always been fascinated by structural geology, I have found the use of quantitative exercises to be helpful in my understanding (or lack thereof) of rock deformations seen on outcrop or via geophysical and subsurface data. Setting up the models can also be fun and lead us to a greater appreciation of the enormity of the tectonic stresses that operate within our dynamic planet.

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## In Memoriam

### Larry D. Woodfork, CPG-02370

*Morgantown, West Virginia  
May 30, 1939 - August 22, 2022*

#### Member Since 1972

*The following information and photograph were excerpted from the Smith Funeral & Cremation Care website...*

Larry D. Woodfork, 83, of Morgantown passed away on Monday, August 22nd, 2022 at Harmony of Morgantown. He was born in Vincennes, Indiana on May 30th, 1939, a son of the late Basil R. and Eva L. Sayre Woodfork.



Larry received his undergraduate and graduate degrees in geology from Indiana University and completed postgraduate studies in statistics and petroleum engineering at WVU. He joined the staff of the West Virginia Geologic and Economic Survey (WVGES) in 1968 and was appointed Assistant State Geologist in 1969. He became Director of the WVGES and State Geologist of West Virginia in 1988 and served in that position until his retirement in 2002. During most of his tenure at the WVGES, he also held appointments as an Adjunct Professor in the Geology and Petroleum Engineering Departments at West Virginia University.

Larry's participation in the geoscience professional organizations was legendary. He served as President of the American Geological Institute (AGI), the American Institute of Professional Geologists (AIPG), and the Association of American State Geologists (AASG). He was Chair of the House of Delegates of the American Association of Petroleum Geologists (AAPG) and was a Senior Fellow of the Geological Society of America. Among the many high honors and prestigious awards which he received are the AIPG Ben H. Parker Medal, AIPG Martin Van Couvering Memorial Medal, the AGI Medal in Memory of Ian Campbell, the AIPG John T. Galey Memorial Medal, as well as Honorary Membership in AIPG, AAPG, and AASG.

Following his retirement from the WVGES, he continued to participate in professional organizations and other activities promoting the geosciences. His largest such endeavor was serving as Chairman of the Board of Directors and Officers of the Corporation of the International Year of Planet Earth (2007 - 2009), a joint global initiative of UNESCO and the International Union of Geological Sciences.

Those acquainted with Larry may have known him as a mentor in the geological community who embodied a positive spirit of encouragement, a world traveler who enjoyed sharing his experiences, a fitness enthusiast who would strike up a conversation at the track, or a man who spoke with pride about his beloved family. He will truly be missed.

### Lee A. Wooderson, CPG-02711

*Lake Havasu City, Arizona  
November 4, 2021*

#### Member Since 1975

*The following information and photograph were excerpted from the Farmington Daily Times website...*

Lee A. Wooderson passed away on November 4th, 2021, at his home in Lake Havasu City, AZ. He and his wife, Judith Lerch Wooderson moved from Bloomfield, NM April 2021 to be closer to his children and their families. Lee and Judith were married for 41 years. He was 86 years old when he died and was born in Manderson, WY to Elmer L. "Jack" and Vero O. Johnson Wooderson.



Lee spent his life as a consulting geologist in mining, oil and gas, and construction. He was a graduate of the university of Wyoming and later in life earned an associate degree in archeology and anthropology at San Juan College in Farmington, NM. Lee retired from San Juan College having worked there for years as an adjunct professor and clerk-of-the-works for the Physical Plant. Lee loved the Lord and attended Mesa View Baptist Church, Farmington, NM. He was also a member of the Sons of the American Revolution, AF & AM Masonic Lodge, York Rite, The Shriners, and many other service organizations. Lee was proud to have served our country in the US Army during the Korean era and for a brief time in the German occupation. As a Chaplain in the VFW 2182, he and his team furnished military honors for more than 1700 deceased members.

### Jutta L. Hager, CPG-07041

*Woburn, Massachusetts  
August 14, 2022*

#### Member Since 1986

*The following information and photograph were excerpted from the Dello Russo Funeral Service website...*

Jutta L. Hager, of Waltham, passed away on Sunday, August 14th at the age of 80. She was born in Frankfurt, Germany. She was born of the late Karl and Elisabeth Hager just before World War Two arrived. She survived a night in a Nuremberg apartment with dud American bombs falling in the front yard.

Karl Hager came to the United States at the end of the war as part of Operation Paperclip. Elisabeth and Jutta joined him several years later at Fort Bliss. There, Karl helped develop fuel tanks as part of Dr. Wernher von Braun's space and ballistic rocket program. The family later moved to Huntsville, AL, then to Clearfield, PA where Jutta found her love of riding horses. Jutta moved to Boston in 1959 to attend Radcliffe (Harvard's Women's institution) where she studied German Literature and traveled to Berlin on a Fulbright scholarship.

Jutta became passionate about the study of geology, obtaining her master's and PhD at Radcliffe. After teaching at Wesley





college, she founded her first geological consulting company in 1984. She founded Hager Geoscience in 1993 and served as its president since that time.

Jutta served on numerous professional boards and worked on projects like looking for WWII airplanes buried in glaciers in Greenland. She presented at conferences around the world and mentored upcoming geologists for over 30 years. Her work was her passion; it was truly a labor of love for her. She ran her business like a family with snacks in the back room and beer after hours on Fridays. Her other loves were wine, travel, and of course her horse Ty, who she spoiled royally and rode frequently, right up until her last months of life.

## Paul S. Glavinovich, CPG-08843

*Anchorage, Alaska*

*August 19, 1939 - April 27, 2022*

### Member Since 1993

*The following information and photograph were excerpted from the Anchorage Daily News website...*

Paul Glavinovich, a lifelong Alaskan, passed away peacefully at his Anchorage home on April 27, 2022.



Paul was born on Aug. 19, 1939, in Nome, Alaska, to Marguerite and Carl Glavinovich. He was an avid hunter and fisherman, who trained and worked his beloved Labrador retrievers as hunting dogs and received honors in field trial competitions. He also received high honors and awards with his German shepherds in several fields, including protection, tracking and rescue. Paul was a longtime member of

Hundesport, Alaska, and volunteered his and his dogs' services in several search and rescue efforts.

Growing up in Nome, where his father was involved in gold dredging operations, Paul developed a passion for mining. He graduated from the University of Alaska Fairbanks School of Mines in 1961. Paul then served in the U.S. Army where he was a training pilot. He flew both helicopters and fixed-wing aircraft, and attained the rank of First Lieutenant. After his military service, he worked with Pan America Petroleum Company, then returned to UAF and earned a master's degree in 1967. While pursuing his Masters, he mapped Denali National Park on foot. He then worked for the USSR & M Company in both Fairbanks and Salt Lake City. He left his position there as Assistant Chief Geologist to join Noranda Exploration in Anchorage in 1974.

As Noranda's District Geologist for Alaska, Paul was a direct participant in the exploration and development of the Greens Creek Mine near Juneau. In 1982, he moved to Denver as Manager, U.S. Exploration for Noranda. He returned to Alaska in 1985 and established his own business as minerals consultant and mine developer. Over the next several decades, he worked closely with Alaska Native corporations. Paul spent nearly 60 years working in the mining industry. He was involved in exploration and development projects throughout North, South and Central America, as well as Western Europe.

Paul served 35 years as a board member of the Resource Development Council, including a term as president of its statewide board. He was also a past president and long-term board member of the Alaska Miners Association, where he served as Chairman of the State Oversight Committee for more than 25 years and was elected Director Emeritus. Paul supported Alaska Resource Education, and often presented lessons in geology to students in the Anchorage School District. In 2010, Paul received the Alumni Achievement Award for Business & Professional Excellence from UAF.

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# The Power of Mentorship: Experiences from an Early Career Mentee

Brigette Petras, ECP-0851

Like many other geologists, I learned about the prospect of a career in geology later in my education. Discovering geology in college was exciting, but the breadth of the discipline can be overwhelming for a student. Although geology wasn't a distinct field of science until the 18th century, there is approximately 4.5 billion of years' worth of Earth's geologic history to study, and processes and products ranging from the molecular to regional scale. Furthermore, geology disciplines can include but are not limited to the following careers: environmental geologists, mining geologists, seismologists, volcanologists, energy and energy storage geologists, planetary geologists, etc.

Since I discovered my passion for geology in college, I had a lot of questions as an emerging scientist and professional. As any good scientist does, they (as I did), keep asking questions of other professionals, and this has been and continues to be invaluable to me. I am grateful for the mentoring I have received, which has enriched my career, greatly helped me to connect with others, and grow and succeed as a geologist.

My first mentorships for geology were my professors at Youngstown State University (YSU) in Ohio. These professors inspired me to explore my opportunities in geology, get connected with other geologists with similar interests, and learn what skills are particularly beneficial to be a geologist. Moreover, I developed my career path, learned new skills, decided to pursue graduate school, and learned about internship opportunities thanks to the guidance of my mentors. Learning through textbooks and coursework develops your geological skillsets but talking to your professors and professionals teaches you how to succeed with your skills. Professors also guided me towards the value of geologic organizations such as AIPG and helped develop my leadership skills to found the AIPG student chapter for YSU as part of the Ohio Section. As a result, this mentorship also benefitted YSU geology students and the Ohio Section.

Other mentorships include advisors, committee members, and other professors in my graduate school at West Virginia University. These mentorships were beneficial in many ways, including building my technical skills and career path. I also learned how to tackle research questions, present research, and communicate science (an invaluable yet sometimes overlooked skill).

Besides academics, I have been mentored at internships, conferences, and organizational programs such as the American Association of Petroleum Geologists (AAPG) Women's Network mentoring program. Internships further develop nontechnical and technical skills. Mentorship programs helped me to connect with other geologists at the peak of the pandemic

*“Professors also guided me towards the value of geologic organizations such as AIPG and helped develop my leadership skills to found the AIPG student chapter for YSU as part of the Ohio Section.”*

when everyone was virtual. Normal networking opportunities at conferences were unavailable until recently because of the lack of in-person conferences. These meaningful connections guided my transition from student to early career professional.

Similarly, the new AIPG mentoring program offers a rare opportunity for students, young professionals, or other professionals to choose mentors from a variety of geologic backgrounds from across the country. AIPG has members across all geoscience specialties who are willing to share their geoscience experiences, expertise and career choices and paths. Please refer to the website to connect with a mentor: [www.aipg.org/page/MentoringProgram](http://www.aipg.org/page/MentoringProgram).

I am also part of the mentoring program at Battelle (a research and applied science institution) in their Energy Division. Many workplaces have structured mentoring programs because they recognize that at the least, connecting and sharing knowledge strengthens the workforce and promotes a positive workplace culture.

Although my perspective of mentorship is from the mentee perspective, there are many benefits to mentors too, such as the following:

- advance critical thinking skills
- grow your professional network
- progress your leadership skills
- gain experience enriching the scientific community

To all those wishing to succeed—keep asking questions and connecting with other professionals. Mentoring can range from a short call, a few months, to a lifelong connection. Mentorship benefits mentees, mentors, organizations, and the scientific community, and is vital to the growth and development of geology.

# THANK YOU, AIPG Mentorship Program



**Hays Slaughter, SA-10132 and Stephanie Thompson, SA-10519**

Both Stephanie Thompson and I (Hays Slaughter) want to send our collective appreciation to AIPG for support received from the AIPG mentoring program over the last couple years. Joining AIPG as undergraduate students has provided invaluable career advice and steered us to employment opportunities. While we did the work, AIPG provided tremendous guidance, support and elevated our confidence along the way. Our mentors helped us make new contacts with people in our selected industries that we would not have made alone. In our undergraduate studies at Columbus State University in Georgia, I was student president of our AIPG student-chapter and Stephanie was the student treasurer. In this article, we want to extend a huge thank-you to AIPG for re-launching the Mentoring Program. After finishing our geoscience degrees earlier this year, AIPG's Mentoring Program was instrumental in directing us to great geology-focused, career starting opportunities.

As we look back over the last year, we received separately great advice through positive virtual interactions. We received great support from our AIPG mentors. The networking within AIPG through our mentors was fantastic. There is a group of experienced geoscience professionals there to help navigate the tough decisions and employment search we all face as new, graduating geologists. Our AIPG mentors provided advice and helped develop action items that led to jumpstarting our geology careers. AIPG's list of mentors has great broad diversity of people with varied geoscience experiences. We strongly recommend all students and young geoscience professionals take advantage of the AIPG Mentoring Program.

The AIPG mentors helped with selecting the area of geology to pursue professionally, graduate schools to research, pros and cons of different career paths, and helped identify and introduce us to others within the AIPG mentoring network. Stephanie landed an opportunity in Elko, Nevada working as an underground mine geologist. I worked for about a year as a junior exploration geologist on a gold project near Fairbanks, Alaska which led to a new opportunity and employer in Beatty, NV. These early career experiences have been once in a lifetime opportunities. (see "A Successful Mentoring Partnership" The Professional Geologist - Jan/Feb/Mar 2022). I originally had success with the AIPG mentorship program and then recommended it to Stephanie. Her AIPG mentor experience was very similar and has her own great story to share:

"Hey TPG readers! I have received so much good advice and support since joining the AIPG Mentoring program. I was at a loss for what to do as my senior year was coming to a close.

I had barely started networking due to COVID and there were no active mining companies near my area that I could pursue or ask for advice. I was amazed to find my geology classmate, Hays, had landed a great opportunity. I asked him brief questions over the next few months on how he did it and he kept saying it was his "mentor" that helped him. It was a lot later that I found out it was an 'AIPG mentor' and that I could also, as a student-AIPG member, get support from this program. My first mentor helped me pin down the exact career and then helped me network with a few individuals in those fields. It took some time, effort, and persistence but I received great advice on what I should be looking for in my first job, and even extra training opportunities. Eventually, thanks to them, I landed my first job as a mine geologist. I could not have gotten such a great opportunity so quickly without the help I received from the AIPG Mentoring Program!"

We want to stress there are no promises and this is not a program for finding a job (a.k.a. an employment agency). The AIPG Mentoring Program is just a group of very experienced geologists looking to help the next generation of geoscientists – an opportunity to give back. As mentees, we did the searches, the emails, the applications, the research, the resume writing, and additional training. However, we believe the AIPG network was critical in establishing connections and providing confidence we were headed in the right direction, doing the right things.

The Mentoring Program is a great resource that can be used to network and help new geoscience graduates and early-career geologists achieve their goals and identify the career or graduate program that suits their geoscience aspirations. If you are a geology major who is graduating in 2023, we can't stress enough how important and helpful you will find an AIPG mentor. You may not know yet what you are going to do with your geoscience degree and that is okay. In our senior year, we had no idea where our geology degrees were going to take us – what new opportunities, what specific job activities or where. And we didn't have a clue how to make it happen. Our professors were helpful, but their advice was limited to their very specific area of research. In both our recent experiences, we found a mentor who is, or has, worked professionally in the geosciences a true benefit and value for career mapping, related searches, professional geoscience career guidance, and significant professional geoscience networking opportunities.

Thanks, AIPG for the Mentoring Program! Graduating or Young Career Professionals – get an AIPG Mentor – plan ahead! The sooner the better! Go explore!!



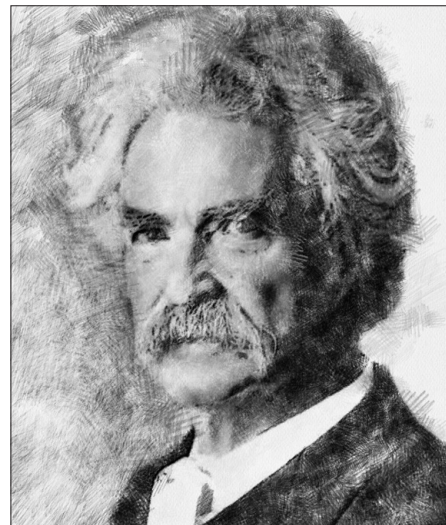


# Data Management and Manipulation

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*"There are three kinds of lies:  
lies, damned lies, and statistics."*

--Mark Twain, who incorrectly attributed the quote to Benjamin Disraeli,  
in Mark Twain's Own Autobiography: *The Chapters from the North  
American Review*



In 2007, I accepted a position as Assistant Professor of Geology at Northwest Missouri State University. Among my duties there was to teach a section of Introduction to Physical Geology in a large lecture hall seating 100 or more students. I always spent the first couple of lectures talking about what science is (and isn't), the types of data we use, and how we analyze that data. In the fall of 2007, I prepared a demonstration for the students that I hoped would illustrate that data can be manipulated. On the projector screen was an image showing a Microsoft Excel spreadsheet open on my computer. In cells B2 and B3 the students could clearly see a number 1. As I was lecturing, I told the students that there are many things that we accept to be true. We know that the sun rises in the east and sets in the west. We know that if we drop a coin or a marble it will inevitably fall to the floor or the ground. And we know that  $1 + 1 = 2$ . At this point, I placed the cursor in cell B4, and entered the formula `= B1+B2;` and hit enter. When I did, the value 3 appeared in cell B4. I heard more than one audible gasp. It appeared, for all intents and purposes, that Microsoft Excel had miscalculated and that for some reason,  $1 + 1$  was now 3.

I asked the students what had happened, but heard no response. With some encouragement, students started to put forward their explanations. Maybe there was a number one in cell B3, but I had changed the font to white so that it couldn't be seen. Perhaps I had written a script that directed Excel to change the value or to increase the value in the cell by 1. The students became sure that some kind of data manipulation was afoot, but they weren't sure how I had made this happen.

I placed the cursor over cell B1, showing the students that the value of the cell was actually 1.49. The same for cell B2. The total that was shown in cell B4 was actually 2.98. I explained that Excel automatically rounds to the nearest whole number in the display, but that the actual number that was entered, decimal places and all, was what was used for the calculation. What appeared to be  $1 + 1 = 3$ , was actually  $1.49 + 1.49 = 2.98$ , but with rounding, the display showed  $1 + 1 = 3$ . My entire point was that data can be manipulated.

Geology increasingly relies on larger and larger data sets. Geostatistics has emerged as a field dedicated to using big data to guide exploration programs or to predict future mineral, gas, or oil production. Managers increasingly rely on data to drive our decision making. Yet, I rarely see discussion of the ethics of data management and analysis.

In fairness, in most instances where data is misused or points to a conclusion that is incorrect, the errors are unintentional. It can be challenging to provide quality control on data sets that consist of thousands or even millions of entries. In some cases, the person utilizing the data may not have the full context within which the data was collected. Where the data might carry a particular numerical identifier, without context it can be nearly impossible to determine if the number in question is accurate or if it is the correct number to utilize for the analysis that is being conducted.

A second and more insidious problem occurs when analysts believe they know what the analytics will show. This can lead to the selection of data that supports a pre-existing supposition

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# HAPPY 60TH ANNIVERSARY!

I extend a warm hello to each of you as I begin my term as 2023 President of AIPG. AIPG has been an important part of my professional and personal life. I joined as soon as I could after accumulating five years of professional experience (a level slightly lower than the current eight years minimum work experience requirement), as a CPG, which was the only member category available at the time. I have served in various capacities at section and national levels. AIPG has provided me tremendous opportunities for personal and professional growth, and I am committed to its mission.

AIPG has adapted and matured with the years and will continue to do so under my presidency. I'm so pleased with many of the changes in the first 60 years that were wise and timely, especially the addition of membership categories beyond the CPG, such as the Early Career Professional (ECP). AIPG's Executive Committee members previously were all required to be CPGs, whereas now an ECP position is available. We have made international agreements with other geologic organizations, such as the Institute of Geologists of Ireland, European Federation of Geologists and the Geological Society of London and continue to seek cooperative agreements with other geo-centric organizations.

In 2023 we celebrate the 60th anniversary of the Institute, a diamond jubilee event, and you will be seeing the diamond symbol a lot this year as we mark the anniversary of the founding of the Institute. The AIPG leadership is planning a variety of activities to commemorate our diamond jubilee, including field trips to Iceland and a party at the annual meeting to be held in September in Covington, Kentucky. The 2023 annual meeting location is on the border of Ohio and Kentucky and is within driving distance of many sections. The location was chosen based on access to fantastic geology plus the desire to make the location accessible to our membership.

## 60 Years Strong

2023 is a year to recognize how AIPG has changed and continues to adapt to current conditions. I suspect that you have noticed some changes – an all-color *TPG* (marvelous!), a series of Town Halls, more technical webinars being offered with CEU

options, and some once-active sections having gone dormant during COVID and are now regaining traction. I've been very pleased with the positive reaction to the Town Halls and "Lunch & Earn" webinars and the number of participants. We plan to continue to offer these virtual meetings and webinars.

I invite you to take advantage of those online opportunities, and if you're not finding a local face-to-face event, reach out directly to your section president or the national office to get involved to organize a local happening. The AIPG national office maintains a speakers list, so even if your section can't organize a face-to-face get-together, a virtual meeting can be organized using our AIPG Zoom account.

Circling back to the 60 years of AIPG, the upcoming annual meeting scheduled for September 2023 will be the party not to be missed! Multiple sections have joined forces to make this an event to be remembered. We have two co-chairs (Christine Lilek from Wisconsin and Shanna Schmitt from Minnesota). Covington, Kentucky is literally across the bridge from Cincinnati, Ohio, so

there is participation from multiple state geologic surveys and field trips planned throughout the region. The meeting is in a central location that features wonderful geology, so members driving to the meeting will be able to take advantage of vehicle storage space for rock and fossil collections. I miss the days when checked luggage meant that if you can carry it, you can check it. I came back with 70-pound bags from AIPG meetings and have fabulous samples from all over the US.

## Visible Value of AIPG Membership

I have seen firsthand the value of AIPG membership on personal and professional levels. My career has benefited directly and indirectly through AIPG participation. I have gotten jobs through AIPG connections. I learned early in my career that geologists are hired for a project and that layoffs are a common occurrence. More than once I've found an opening by asking other AIPG members for leads. When I originally was looking to relocate from southern California to Tucson, Arizona in 1991, I called up an AIPG member out of the directory and asked

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1. Which of the following is not part of the plagioclase feldspar series:
  - a) Sanidine.
  - b) Andesine.
  - c) Oligoclase.
  - d) Labradorite.
  - e) No feldspars for me, dude; ferromagnesians rule! Viva olivine! Viva augite! Viva...
  
2. In the seismic reflection method, which of the following is used to calculate depth to a horizon?
  - a)  $D = (V * T)^2$ .
  - b)  $D = \frac{3}{4} (V * T)^{\frac{1}{2}}$ .
  - c)  $D = \frac{1}{2} (V * T)$ .
  - d)  $D = 0.75 * (V^6 * T^4)$ .
  - e) Mathematical mad geophysicist genius says: Using a strong reflective light to illuminate the drill site, dig a whole at any angle, as fast as you can, at a constant rate of speed, accurately timing yourself and, as you reach a horizon of interest, calculate the vertical depth using the formula  $D = \cos \phi + \int x^{n-1} dx$ ...
  
3. Which of the following examples of chemical weathering describes the process of hydrolysis?
  - a)  $\text{CaSO}_4 \rightarrow \text{Ca}^{++} + \text{SO}_4^{--}$  and  $\text{Ca}^{++} + \text{SO}_4^{--} + 2\text{H}_2\text{O} \rightarrow \text{CaSO}_4 * 2\text{H}_2\text{O}$
  - b)  $2\text{KAlSi}_3\text{O}_8 + 2\text{H}^+ + 2\text{HCO}_3^- + \text{H}_2\text{O} \rightarrow \text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4 + 2\text{K}^+ + 2\text{HCO}_3^- + 4\text{SiO}_2$
  - c)  $\text{Fe}_2\text{SiO}_4 + 4\text{H}_2\text{CO}_3 \rightarrow 2\text{Fe}_2 + 4\text{HCO}_3 + \text{H}_4\text{SiO}_4$  and  $2\text{Fe}_2 + 4\text{HCO}_3 + \frac{1}{2}\text{O}_2 + 2\text{H}_2\text{O} \rightarrow \text{Fe}_2\text{O}_3 + 4\text{H}_2\text{CO}_3$
  - d)  $\text{H}_2\text{O} + \text{CO}_2 \rightarrow \text{H}_2\text{CO}_3$  and  $\text{H}_2\text{CO}_3 \rightarrow \text{H}^+ + \text{HCO}_3^-$  and  $\text{H}^+ + \text{HCO}_3^- + \text{CaCO}_3 \rightarrow \text{Ca}^{++} + 2\text{HCO}_3^-$
  - e) Good grief! This looks like a bad-tasting alphabet soup, dude...
  
4. In reference to the oceans, what is referred to as the CCD or "carbonate compensation depth?"
  - a) The depth at which calcium carbonate comes out of solution and precipitates forming carbonate-rich sediments.
  - b) The isostatic compensation level for carbonate rocks.
  - c) The depth at which carbonate minerals dissolve faster than they can accumulate.
  - d) The depth to which one can dive and be financially compensated for collecting carbonate samples.
  - e) I have the right answer for this one too, dude! I'm on a roll! I'm in the zone! I'm batting a thousand! I'm unstoppable now! I'm la crème de la crème! I walk the walk!...
  
5. As we know, clastic particles may undergo rounding and volume reduction during erosion and transportation. We are also cognizant that particle size, shape, composition, density, volume and additional factors can impact the internal fabric, packing geometry, porosity, permeability and other related properties which characterize sedimentary deposits. Consider, for example, a quasi-spherical silicic clast originally measuring 6.00 mm in diameter. After transportation over a certain distance, its diameter is decreased by 0.04 mm. What is the approximate volume of silicic material lost during the trajectory?
  - a) 2.26 mm<sup>3</sup>.
  - b) 2.97 mm<sup>3</sup>.
  - c) 3.01 mm<sup>3</sup>.
  - d) It just chips away, dude! Don't complicate things, man. I'm just content with floating down the river, riding my inner tube, along with my ice chest, drinking.





### Topical Index-Table of Contents to the Professional Ethics and Practices Columns

A topically based Index-Table of Contents, "pe&p index.xls" covering columns, articles, and letters to the editor that have been referred to in the PE&P columns in Excel format is on the AIPG web site in the Ethics section. This Index-Table of Contents is updated as each issue of the TPG is published. You can use it to find those items addressing a particular area of concern. Suggestions for improvements should be sent to David Abbott, [dmageol@msn.com](mailto:dmageol@msn.com)

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## Whatever happened to Multiple Working Hypotheses?

James Gooding's (Mem-3070) article, "Whatever happened to multiple working hypotheses?", in the Oct/Nov/Dec '22 TPG is an excellent review of an important topic. I was struck by the section "Scientific tools identified as 'models' do not universally deal with uncertainties." As Gooding points out, the use of models in guiding the exploration for and development of mineral deposits has been an important concept that was developed in Lowell, J.D., and Gilbert, J.M., 1970, *Lateral and vertical alteration-mineralization zoning in porphyry ore deposits*: Economic Geology, v. 65, p. 373, and further outlined by S.S. Adams in, 1985, *Using geological information to develop exploration strategies for epithermal deposits*: Reviews in Economic Geology, v. 2, Society of Economic Geologists.

My own experience in studying the estimation of the mineral resources and mineral reserves in the J-M Reef at the Stillwater and East Boulder Mines in the Stillwater Layered Igneous Complex of south-central Montana over the years (1997–2017) provided another viewpoint regarding the hypotheses proposed to explain the origin of the palladium-platinum-bearing J-M Reef and similar deposits of the Bushveld Complex in South Africa (although different in important details). After reading various papers proposing to explain the Pd-Pt deposition processes, I concluded that the number of hypotheses for the Pd-Pt deposition was greater than the number of experts proposing such hypotheses by at least 1. However, the practical issue for Stillwater Mining Company was not in definitively explaining the depositional process(es) but rather in developing a consistent methodology for estimating the mineral resource and mineral reserve quantities remaining

as the mines expanded over the years. While the Lowell and Gilbert model for porphyry systems has held up well and is useful in exploration and deposit delineation, such a model is not necessarily needed to delineate a deposit and estimate its mineral resources and mineral reserves.

An excellent related short article, *The rocks don't lie, but they can be misunderstood*, was the lead article in the October '22 issue of *GSA Today*. The authors, Allen K. Glazner, Victor R. Baker, John M. Bartley, Kevin Bohacs, and Drew S. Coleman have rewritten a key part of T.C. Chamberlin's (1890) *The method of multiple working hypotheses* in condensed and modern language:

The moment that you come up with an explanation for a phenomenon, you develop affection for your intellectual child, and with time this grows ever stronger. You proceed rapidly to acceptance of the theory, followed by unconscious selection of data that fit and unconscious neglect of data that do not. Your mind lingers with pleasure on facts that confirm the theory and feels a natural coldness toward those that do not. You search instinctively for data that fit, for the mind is led by its desires. When these biases set in, the collection of data and their interpretation are dominated by affection for the favored theory until you are convinced that it has been overwhelmingly confirmed. It then rises to a position of mind control, guiding observation and interpretation—from a favored child into your master.

When this last stage has been reached, unless the theory happens to be correct, all hope of progress is gone.

Some geologic questions can be resolved by smoking gun evidence, for example, the iridium anomaly and

shocked quartz evidence for the latest Cretaceous bolide impact. The authors also point out that a soil scientist may pay little attention to granitic bedrock while a granite petrologist will ignore the overlying soil. The authors point out studies that have radically changed the interpretations of the emplacement of granites in Yosemite National Park.

The large K-feldspar phenocrysts in calc-alkaline granodiorites led to the field-based hypothesis that the phenocrysts grew early in the crystallization of the granodiorite. But a large and consistent body of experimental and petrographic data shows that K-feldspar is the last major phase to begin crystallization. The large K-feldspar phenocrysts likely grow and recrystallize to highly potassic compositions by a displacive process akin to the growth of garnets in schist.

The article, *the rocks don't lie, but they can be misunderstood*, is an excellent update and discussion of the consistent need for multiple working hypotheses to explain geologic phenomena. Read it.

## Seeing things as they are, not as you wish they were

In *The Scout Mindset: why some people see things clearly and others don't* (2021, Portfolio/Penguin), Julia Galef addresses the perception issues involved in the multiple working hypotheses issue. Galef defines the scout mindset as "the motivation to see things as they are, not as you wish them to be. [The] scout mindset is what allows you to recognize when you are wrong, to seek out your blind spots, to test your assumptions, and change course. It's what prompts you to honestly ask yourself questions like 'Was I at fault in that argument?' or 'Is this risk worth it?' or 'How would I react if someone from the other political party did the same thing?' As the late physicist Richard Feynman once said, 'The first principle is that

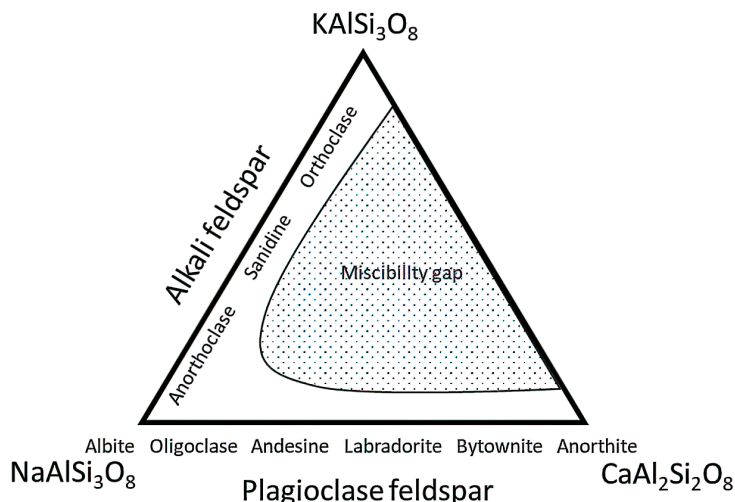
*Continued on p. 41*

**Answers:**

1. The answer is choice “a” or “Sanidine.” Sanidine is a high-temperature form of potassium feldspar ( $\text{KAlSi}_3\text{O}_8$ ). Labradorite  $\{(\text{Ca},\text{Na})[\text{Al}(\text{Al},\text{Si})\text{Si}_2\text{O}_8]\}$ , andesine  $[(\text{Ca},\text{Na})(\text{Al},\text{Si})_4\text{O}_8]$  and oligoclase  $[(\text{Na},\text{Ca})[\text{Al}(\text{Si},\text{Al})\text{Si}_2\text{O}_8]]$  are members of the plagioclase feldspar series.

2. The answer is choice “c” or “ $D = \frac{1}{2} (V * T)$ .”

Velocity is distance over time. In our case, distance is depth. In the seismic reflection method, seismic energy travels downward through strata from the shot point to the reflector and then back upward through the same strata to the receiver. To account for the two-way travel time, we must divide by two.



3. The answer is choice “b” or “ $2\text{KAlSi}_3\text{O}_8 + 2\text{H}^+ + 2\text{HCO}_3^- + \text{H}_2\text{O} \rightarrow \text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4 + 2\text{K}^+ + 2\text{HCO}_3^- + 4\text{SiO}_2$ .” “Hydrolysis” is a type of chemical weathering which breaks mineral compounds using water. New minerals may be created in the process. In the above reaction, potassium feldspar weathers into kaolinite clay.

Choice “a” illustrates the chemical weathering process of “hydration” where water is introduced into the mineral’s chemical formula. In the example, anhydrite hydrates into gypsum.

Choice “c” shows the chemical weathering process of “oxidation” which involves the loss of electrons during a chemical reaction. The example shows the weathering of olivine (fayalite) into hematite.

Choice “d” demonstrates the chemical weathering process of “carbonation”, or the combination of water and carbon dioxide to create carbonic acid, and the role of carbonic acid in the dissolution of calcite.

4. The answer is choice “c” or “The depth at which carbonate minerals dissolve faster than they can accumulate.” The CCD occurs at ocean depths between 4,000 and 5,000 meters.
5. The answer is choice “a” or “ $2.26 \text{ mm}^3$ .”

**Given:**

$$D_o = 6.00 \text{ mm or } r_o = 3.00 \text{ mm} \quad (1)$$

$$D_f = 6.00 - 0.04 = 5.96 \text{ mm. or } r_f = 2.98 \text{ mm} \quad (2)$$

**Then:**

$$V_o = \frac{4}{3} \pi r^3 \quad (3)$$

**Differentiating:**

$$dV = 3 * \left(\frac{4}{3}\right) * \pi * r^2 * dr = 4\pi r^2 dr \quad (4)$$

**Substituting:**

$$dV = 4 * 3.1416 * (3.00)^2 * (3.00 - 2.98) = 2.26 \text{ mm}^3 \quad (5)$$

Thus, the approximate volume of silicic material lost during the trajectory is 2.26 cubic millimeters.



*Professional Ethics continued from, p.39*

you must not fool yourself—and you are the easiest person to fool.” “Knowing that you should test your assumptions doesn’t automatically improve your judgment, any more than knowing you should exercise automatically improves your health. Being able to rattle off a list of biases and fallacies doesn’t help you unless you’re willing to acknowledge those biases and fallacies in your own thinking.”

Galef’s approach to the scout mindset is based on three prongs:

1. Realize that the truth isn’t in conflict with your other goals.
2. Learn tools that make it easier to see clearly.
3. Appreciate the emotional awards of the scout mindset.

Galef contrasts the scout mindset with the defensive mindset. Beneath our conscious awareness, we’re soldiers defending our beliefs. Our beliefs are built on ‘solid foundations’ that are ‘deep-rooted, well-grounded, built on fact,’ and backed up by arguments. We defend against those who poke holes in or shoot down our ideas. We seek additional evidence to support or buttress our position in order to reinforce the strength of our beliefs. Changing our mind amounts to surrender, the giving up of an indefensible position. Martial imagery infuses all these words and concepts.

The scout mindset is less set in concrete. It asks:

- “Can I believe it?” versus “Must I believe it?”
- Is it true?
- It stress tests our plans.
- What happens if I fail?
- Am I being objective?
- Can my accuracy be improved?

We all act from both the soldier and scout positions. However, by paying attention and being more open-minded our positions can become more scout-oriented and flexible and we’re willing to change as needed.

Galef notes that we all have identities that we hold more or less firmly. We’re all geoscientists, but what type: mining, petroleum, environmental, hydrologic, academic, etc.? Do we identify strongly with a political party and always vote

straight ticket, or do we split tickets? What and how firm are your religious beliefs? Are you an omnivore or vegetarian, or vegan, and how strongly do you assert your identity? Are you willing to recognize that those on the other side (those with a different identity) may have good ideas? Identities are another form of potentially unrecognized bias leading to a defensive mindset.

*The Scout Mindset: why some people see things clearly and others don’t* is worth reading and hopefully will assist you in thinking more like a scout than a soldier.

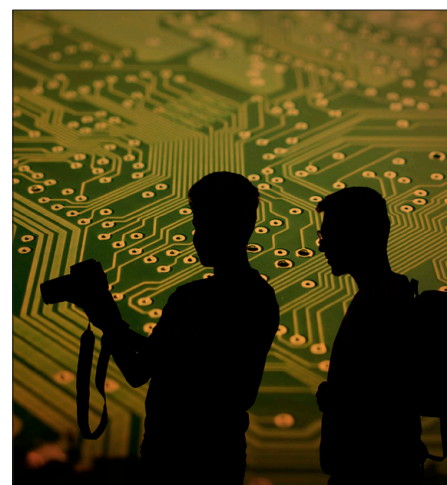
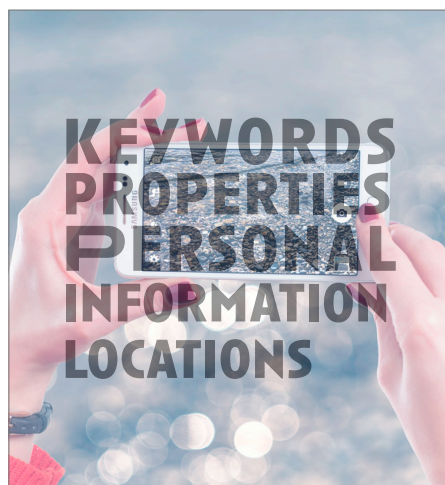
### **Meta-data saved with photos inserted into documents—save it or delete it?**

Photos (JPG, TIFF, and various RAW formats) contain extra, hidden, meta-data. If a photo is copied to and presented in a printed image, the meta-data for this picture may be viewable by right-clicking on the photo and selecting “properties.” A properties box will appear with tabs for “general,” “backup,” “security,” “details,” etc. Depending on the device used to capture the picture (camera, cell phone, tablet, etc.) a variety of meta-data may be available including the camera used, latitude, longitude, date created, date modified, pixel size, dpi, and a variety of other information. Sometimes this meta-data is information you would like saved and sometimes not. Pictures of geologic features, outcrops, sample locations, etc. are examples for which the retention of the meta-data may be very important for scientific purposes. However, pictures of family members and events may be examples of pictures for which

you have no desire for the meta-data to be public. The “properties” dialog box that displays the meta-data for the picture should have a “Remove Properties and Personal Information” link at the bottom of the box that allows the meta-data to be removed from the file being inserted someplace.

Practicalities: first, examine the properties and meta-data retained with the original of your pictures. Knowing the types of meta-data saved with the picture will allow deciding if you want to have that information shared with others. For some of your project photos, you may wish to be sure that information like latitude, longitude, photo properties, lens descriptions, etc. are indeed recorded. Take practice pictures and make adjustments as necessary.

Previous PE&P columns 61 (Jan ‘01), 90 (Mar ‘04), 92 (Jul ‘04), and 134 (Jul ‘11) have addressed meta-data issues in a variety of documents. Printing files to be distributed in PDF format often can eliminate these problems.



*Executive Director, continued from p.36*

or the use of statistical tests that erroneously provide numbers that support a preferred explanation. In some cases, the data may be manipulated to provide the appearance that the data support the preferred conclusion, when an honest examination of the data will show that the opposite conclusion is true. My inspiration for the  $1+1 = 3$  trick was an exploration geology report that had a cut-off grade of 2%. When I started to look at the spreadsheet and to investigate individual cell values, I found that more than half of the ore-bearing samples had assays that were between 1.51 and 1.58% which is nearly 25% below the cutoff grade, yet the rounding function listed each assay as 2%. Fortunately, the exploration manager did their due diligence and recognized that the orebody in question was not economic. I don't know what happened to the geologist who created the initial report.

Our adherence to a code of ethics is among the most important of our responsibilities as members of AIPG. Our code of ethics, first written in 1963 and updated through the years, provides an ethical and professional framework that guides us, even as our profession changes. Whether we use a plane table and alidade or a total station, a hammer and hand lens or an atomic absorption spectrometer, the AIPG Code of Ethics is our guide. The analytical tools we use and the volume and type of data we collect may change, but professional ethics still apply.

*I wish each of you a warm winter.*

*Aaron*

*President, continued from p.37*

about the job market. Can you believe that this AIPG member spent most of a day with me and took me around Tucson to visit some of the companies (thank you, Gary Hix!). And I got a job at one of those companies! The generosity of AIPG members is reflective of the nature of the Institute. A quick poll around the Executive Committee meeting in February 2022 showed about half of those present also had a direct connection through AIPG to an employment opportunity.

I also have benefited from being side by side with senior AIPG personnel when I didn't have those opportunities at work. I've testified before government committees and had meetings with elected officials and staff. I've had

international perspective recently when I visited the Institute of Geologists of Ireland in Dublin while on vacation. They used AIPG's ethics code as a model for their code.

AIPG plays a key role in supporting licensure of geologists through our members who sit on the state registration boards and who work with Association of State Boards of Geology (ASBOG) as subject matter experts in the development of registration exams and as ASBOG officers. Geology is a self-regulating profession that requires the participation of many geologists to carry out the licensing duties of boards and certification duties of AIPG. We can be proud to see AIPG's leadership role throughout the country.

**“The profession of geology recognizes the value of AIPG certification. AIPG plays an extremely important role in providing and maintaining the CPG program.”**

leadership opportunities that are just not common for junior and mid-level staff. All these experiences have been extremely valuable in my professional development. It's a rare employer that can give the mentoring time and well-rounded experiences that grow junior staff into senior leadership. On a personal level, the friendships, camaraderie, and trips associated with AIPG have been a fantastic bonus. These are my people and I've been places with AIPG that wouldn't have been accessible otherwise. Some days being a geologist is such a joy, and I feel very lucky to have found not just a livelihood but a career and profession that is life-long.

The profession of geology recognizes the value of AIPG certification. AIPG plays an extremely important role in providing and maintaining the CPG program. Since I work in the mining industry, I work internationally on a routine basis and use my CPG seal often. Did you know that AIPG is one of the few qualifying organizations that allows me to sign off on public disclosure documents under Canadian rules and regulations (NI 43-101 reports)? There is a high level of respect for the organization and AIPG does not view the CPG credential lightly. I also observed the value of AIPG from an

### Adapting with the Times

Although I just highlighted some of the benefits of AIPG membership and the visible role that AIPG has in the profession, that doesn't mean that things are stagnant. I may be a creature of habit in where I sit in a classroom setting, but I certainly am not stuck in a no-change policy when it comes to work or AIPG matters. Part of being an adult is to deal with the issues that are uncomfortable, and to prioritize where resources (time and money) are invested. That leads me to some items that AIPG leadership has been discussing and some work ahead of us.

As part of your membership renewal, I prepared a letter regarding the discussions held about dues. AIPG's Executive Committee decided not to raise the National dues for 2023. It was not a decision made lightly, and there was plenty of debate about the 2023 budget and how the Institute can carry out its mission and activities during these uncertain financial times. AIPG is not financially robust because our primary income (membership dues) does not cover our annual budget; in fact, we're in the same boat as other geologic organizations.



Everyone is feeling the burden of increasing prices. Your leadership looked at both sides of the argument and there is sound reasoning for an increase upward in dues as well as for staying the course. It has been three years since the last increase and inflation has significantly increased. On the other hand, those who are cost-sensitive are going to be less likely to renew their dues. We currently are using the same dues structure that we've had since 2020. Our dues are not unreasonable; in fact, AIPG CPG dues are less than the similar registered member option under SME.

Getting to a balanced budget in 2023 meant that we reduced spending in some areas, implemented a salary freeze for headquarters staff, and that we are using money from the AIPG reserve funds. Our reserve funds are currently at more than one year's operating budget, so the Executive Committee felt comfortable with using the reserve funds. Achieving a better financial footing and providing more value to membership are two very important goals of every AIPG Executive Committee, and the mechanisms to achieve these goals change over time.

There have been some discussions about how to increase membership (our primary income) and other means to improve financial stability. I have proposed an ad hoc committee that will delve into options, including whether some sort of mechanism would be appropriate to share our administrative operations. There have been discussions in the past about the number of geologic organizations and the burden of each operating independently. In the past there was interest but not much movement. Today, however, too many geologic organizations are struggling, and recent discussions have indicated

that there is increased interest in some sort of way to build a common foundation while still allowing the specialty groups to function. AIPG has a very specific and unique niche. Our role as a 501(c)(6), which allows us to lobby on the behalf of the profession, our CPG program, and our recognition by international groups are all critical and need to be maintained. Other operational functions, such as administrative functions of maintaining a bricks and mortar office, communications to membership, our website, event planning, etc., could all be considered as opportunities to combine and share services. Remote workspaces and on-demand production of logo items have decreased the need for office space. Subleasing in another organization's building and sharing personnel are examples of possible ways to revise the business model. Agreements between multiple organizations can mean joint activities and access to expertise that we don't currently have in-house. Strength in numbers!

## Appreciation

Our 2022 Executive Committee members, section leaders, members who have been outstanding contributors, and our staff were all recognized and thanked during the 2022 annual meeting and conference in Marquette, MI. I also want to extend my personal thanks here to all of them and to our members everywhere who make up this Institute. It can't be said often enough that without our members there is no AIPG. Thank you for your support and for your efforts on the behalf of the Institute and the profession of geology.

# Traveling Old and New Paths: MN/WN AIPG Geology Weekend

## Contributed by Minnesota and Wisconsin Sections

The Minnesota and Wisconsin Sections have a lot in common. We are both trying to find paths forward to address the concerns of emerging contaminants, contaminant risk in karst areas, increasing impacts to our wetlands, and continued mapping needs across our states.

Sixty-five professional geologists, students, and guests gathered in La Crescent, Minnesota from September 30 to October 2, 2022, to address these concerns with topic presentations and field trips to areas of southeast Minnesota and southwest Wisconsin experiencing these challenges.

During our weekend, we used traditional paths of teaching: oral and poster presentations; field trips; networking together but our learning and sharing followed many new paths during this geology weekend.

We want to share some of these new paths of learning with you.

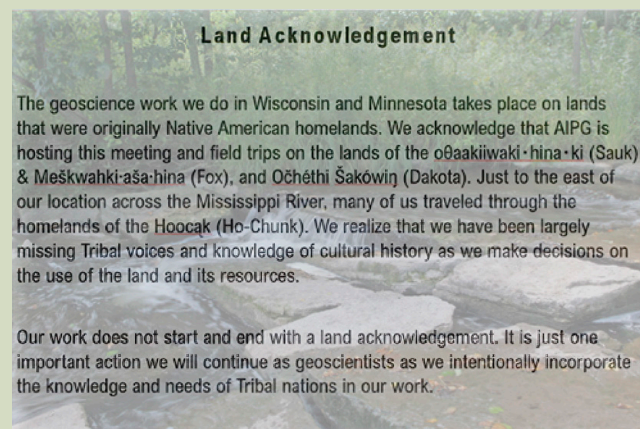
## Tribal Land Acknowledgement

Our first new path was presenting a Tribal Land Acknowledgement slide during the weekend. The slide was shown before, between, and at the end of the presentations.

Paula Leier-Engelhardt – WI Section President conferred with the Wisconsin Geological and Natural History Survey to

develop an acknowledgement statement that fit the MN/WI Geology Weekend location.

We had the statement reviewed by Marlon WhiteEagle from the Ho-Chunk Nation, as we wanted to ensure that the first peoples who inhabited and traveled through the lands we were now visiting and discussing, knew we acknowledge their



Land acknowledgement slide.  
Created by Paula Leier-Engelhardt.

*Continued on p. 51*

# ENVIRONMENTAL GEOLOGY WORKBOOK

By Jack W. Travis (CPG- 07378)  
Published by Waveland Press, Inc.

Reviewed by Frederick Simms, CPG-10292

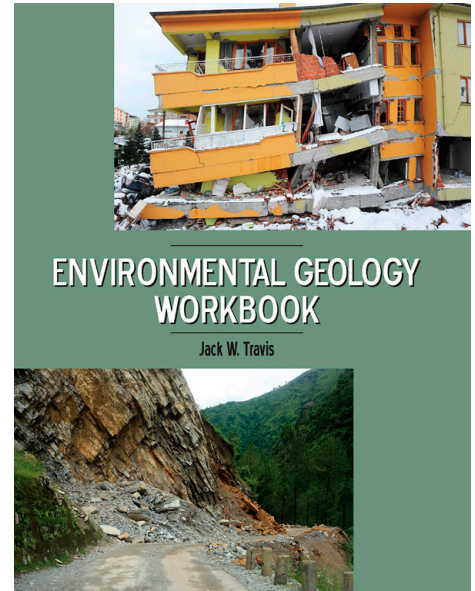


Image source: [www.amazon.com](http://www.amazon.com)

## Book Description

*Environmental geologists use a wide range of geologic data to solve environmental problems and conflicts. Professionals and academics in this field need to know how to gather information on such diverse conditions as soil type, rock structure, and groundwater flow and then utilize it to understand geological site conditions. Field surveys, maps, well logs, bore holes, ground-penetrating radar, aerial photos, geologic literature, and more help to reveal potential natural hazards in an area or how to remediate contaminated sites.*

*This new workbook presents accessible activities designed to highlight key concepts in environmental geology and give students an idea of what they need to know to join the workforce as an environmental geologist, engineering geologist, geological engineer, or geotechnical engineer.*

Source: <https://www.amazon.com/Environmental-Geology-Workbook-Jack-Travis/dp/1478602015>.

The author, Professor Jack Travis, has taught and consulted in environmental geology for many decades. I have likewise taught science courses including Geological Site Assessment while performing environmental consulting in Michigan. My emphasis has been on active learning and that is the robust thrust of Jack Travis's workbook. An internet search shows that there are at least ten authors of environmental geology books including geology for engineers and environmental scientists. The subject workbook is unique as it emphasizes active learning with many real-life examples that have been gleaned from over one hundred professional contributions. Although it was written as a supplement to a lecture textbook, it might serve as a textbook. Professionals also would find this book useful. As the workbook is in black and white (environmentally friendly) and some of the educational materials are provided at the author's web site, it is not so expensive when comparing prices of recent editions of similar books. It is available to rent at the low price of \$13.58 on Kindle.

The chapters of this spiral bound book have explanations of fundamentals, detailed exercise explanations, make great use of internet resources and are very practical. The exercises are of

such an extensive variety that individual ones could be selected to meet the particular needs and interests of students and teachers. There is a good mix of quantitative and judgement type questions such as that concerning the Puna Geothermal Venture. "What is the future of this power source?"

Listing the chapter topics shows the meat of this workbook:

- Locating Geological and Cultural Data and Literature for an Environmental Investigation
- Using the Scientific Method, Graphs, and Statistical Approaches to Solve Geoenvironmental Problems
- Identification of Earth Materials, Minerals and Rocks
- Engineering Properties of Earth Materials
- Recognition of Geologic Hazards with Remote Sensing Devices and Aerial Photographs
- Recognition of Geological Hazards on Topographic Maps, Geologic Maps and Soil Maps
- Earthquake Hazards; Hazards from Volcanic Activity; Landslides and Slope Stability Analysis



- Stream Flow Data and Flooding; Estimating Amounts of Soil Erosion and Sediment Yields
- Groundwater and Associated Problems; Hazards and Problems Associated with Coastal Processes Hazards Associated with Glacial and Periglacial Processes
- Problems Associated with the Siting of a Waste Disposal Facility
- Site Assessments and Environmental Impact Statements; Detecting Contaminated Soil and Groundwater Remediating Contaminated Soil and Groundwater
- Hazards Associated with Nonrenewable Resources Extraction
- Environmental Laws and Land-Use Planning

The appendices include a General Health and Safety Plan, t-Distribution Percentiles, f-Distribution Percentiles,  $\chi^2$ -Distribution Percentiles, Notations Concerning Geotechnical Properties of Soils and Rocks, Glossary of Environmentally Related Abbreviations and Acronyms and Aerial Stereograms. The zip file at the author's website site includes one hundred or more impactful diagrams, graphs, color maps and aerial photographs for the exercises described in the workbook. Some of the internet exercises associated with other websites make it necessary for the student to provide personal information and create passwords and to read documents to understand the associated programs and zip files. Downloading of detailed data is necessary so the student should have the availability of an up-to-date computer and good internet navigation skills. For example, to download Landsat 5 scenes: "Make sure your computer can handle demands before starting the exercise." Students may need to make enlarged maps for some exercises. The instructor may need to evaluate website exercises as I have not done so in detail.

Textbooks and workbooks often require the teacher to supplement exercises with additional information, and here are some thoughts that might be considered for teachers to discuss and clarify. To speed up the assessments, environmental data reports that list most federal and other data on specific sites are available from commercial sources with a rapid turnaround. Customers often want their Phase I in three weeks or less. Business and city abstracts of past occupants of addresses are especially helpful in determining the kinds of activities that have occurred going back many years. Some of the questions in the statistical exercise might fit better in a later chapter on remediation. X-ray diffraction and other mineral identification methods might be used, for example, to identify the type of clay that occurs that could affect soil strength and earth movement events. Older versions of topographic maps can show changes in cultural features. I think the initial statement concerning earthquake prediction should be clarified so the students know that it is still an ongoing topic that needs effort and support.

Air pollution is a significant issue and is being given significant emphasis these days. In some states there are very specific standard protocols for sampling methane vapors at different depths in landfills. In Michigan and other states, volatilization to indoor air is being given high priority and sub-

“I think Professor Travis' workbook is an enormous educational contribution and shows a deep commitment to our profession and society in general.”

slab monitoring of the soil below buildings is often necessary for extended periods.

The term “red flag” is used to indicate that a significant environmental condition occurs - this is equivalent to the term Recognized Environmental Condition (REC) per the ASTM Environmental Site Assessment (ESA) guidelines. There are other classifications including Historical Recognized Environmental Conditions (HREC) and Controlled Recognized Environmental Conditions (CREC).

For property transactions, it should be emphasized that the new owner or occupant of a contaminated site has additional responsibilities beyond performing a Phase I and possibly a Phase II, etc. They need to develop and perform procedures and controls so that any individual on the site is not exposed to harmful contaminants long after the property transaction. For closures of contaminated sites, parts of properties can be restricted for use under certain conditions – for example a water well will not be allowed on parts of the property.

As part of critical thinking, the students need to learn how to develop a conceptual model and evaluate the associated pathways of environmentally impacted sites. This is often necessary to meet regulations and to efficiently bring a site to closure.

Finally, a salient example of the thoughtful nature of this workbook is from the chapter on earthquakes. There is a striking comparison of the timing of the large earthquakes in California and the introduction and passing of legislation related to earthquakes. Psychologists have shown that individuals mostly remember recent events and past extraordinary events. Environmental professionals need to recognize that there is a significant societal aspect to getting enough citizen financial support for improving the environment and reducing risk, and part of their work should be explaining to citizens the need to support research activities, zoning laws etc.

I think Professor Travis' workbook is an enormous educational contribution and shows a deep commitment to our profession and society in general. He needs some recognition for his steadfast and encyclopedic effort!

*Ohio Section Meeting*

# Legacy Lead (Pb) In Urban Soils: An Ongoing Source of Exposure

Brigitte Petras, ECP-0851

*Editor's Note: This article originally appeared in the November 2022 Ohio Section Newsletter.*

The Ohio Section held its Fall 2022 meeting and dinner presentation at Chateau Michele in Canton, Ohio on Thursday, September 15. The event was sponsored by Alpha Analytical, ALS Environmental, Buckeye Elm Contracting, Environmental Remediation Contractors, Environmental Risk Information Services (ERIS) Ohio Soil Recycling, White Oak Environmental and K3 Complete. Prior to the buffet style dinner being served, President Robert Andrews (CPG-11795), addressed the attendees with welcoming remarks. Robert discussed the successful AIPG national meeting in Marquette, Michigan, and reminded everyone next year's national meeting in Cincinnati.

Dr. David Singer was the distinguished speaker of the evening. Dr. Singer is an associate professor at Kent State University's department of geology who researches environmental mineralogy and geochemistry. His presentation "Legacy Lead in Urban Soil: An Ongoing Source of Exposure" highlights multiple studies he has conducted to understand the concentration and distribution of lead in urban soils.

Dr. Singer outlined that natural concentrations of arsenic are typically 10-100 ppm. Lead in the body can be adsorbed to the bone or be in the bloodstream, and the latter is more hazardous to human health.

Historically, lead has been documented to have been used in products and processes since 5000 B.C.E. Leaded paint and gasoline are some of the most common sources of lead

contamination in urban areas. Leaded paint production peaked in the 1940s, while leaded gas peaked in the 1990s.

Maps of lead poisoning were noted in Cuyahoga County. In 2017 there was a decrease in lead poisoning due to replacing lead pipes and educating others about lead paint. However, 20% of the population in certain areas of Cuyahoga County still have elevated levels of lead in their bloodstream. This continued lead exposure is neighborhood dependent, whereas communities with more gas emissions that are closer to Cleveland have these elevated lead levels. These areas are primarily minority communities. The source of this lead is in paint, lead dust, and in soil. Taking soil samples to test for lead concentrations is a proactive response for helping these communities.

Dr. Singer highlighted that 400 ppm of lead in soil is the EPA's risk level for garden and agricultural soil. The relationship between elevated blood levels and the amount of soil in lead was plotted. Overall, there is positive feedback between the two variables. However, there are difference trendlines and models that are non-linear. Moreover, concentrations of lead below 400 ppm can have elevated blood levels of lead. Dr. Singer thinks this nonlinear relationship is caused by speciation of lead. The total concentration of lead does not equal the speciation. Lead can be ingested, inhaled, or absorbed to cause elevated blood levels with lead. Based on Dr. Singer's research, the three factors that influence elevated concentrations of lead in the soil are the following: bioaccessibility, particle size, and the type of coating. Transformations such as wind distribution and





Dr. David Singer presenting to the Ohio Section audience.

highway infrastructure could also play a role in the variability of lead concentrations. Transformations were not the focus of this talk.

Dr. Singer acquired a seed grant and manages a project-based learning program in Akron and Painesville. There is also the Science for Community Change program that educates students in Painesville. These two programs enabled these communities to take soil samples to map the distribution of lead in Akron and Painesville.

The methodologies used for these studies include the following: solid characterization (XRF, XRD, SEM, LOI), lead speciation, and GIS analyses.

The first study was a small-scale project characterizing the distribution of extractable lead in the soil around the house. This process involved using weak to strong acids in a sequential order to extract these concentrations. Spatially, more extractable lead concentrations were found close to the house perimeter, while less were identified further from the house. The temporal variations in the soil column had little change, and the speciation trend remained relatively the same as well.

The second study focused on two neighborhoods in West Akron and Summit County. Nitric acid extraction was utilized as a proxy to take the most bioaccessible lead speciations from the soil.

Galena identified in the soil was likely sources from raw sewage or more likely from rubber emissions from production. By conducting an isotopic analysis, paint and gas are likely sources for Summit, while Akron's source of lead could be from coal fly ash.

A third study highlighted by Dr. Singer evaluated a city distribution of lead from 11 schools of 100+ student participants. No strong correlations of data has been noted

yet, so additional trends of other elements will be evaluated to find a relationship.

Ultimately, lead soil remediation is costly, and lead in soil diminishes through time. A proactive response is best for now.

After some thoughtful questions were answered, Section President Andrews presented Dr. Singer with a decorative plaque adorned with the Ohio state fossil, *Isotelus*. Robert again thanked everyone in attendance, and especially the following sponsors of the event: Alpha Analytical, ALS Environmental, Buckeye Elm Contracting, Environmental Remediation Contractors, Environmental Risk Information Services (ERIS) Ohio Soil Recycling, White Oak Environmental and K3 Complete.



Robert presenting Dr. Singer with a plaque bearing the Ohio State fossil, the *Isotelus Maximus*, as a token of appreciation for speaking.





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Rasoul Sorkhabi, Ph.D., CPG-11981

Dr. Rasoul Sorkhabi is a professor at the University of Utah's Energy & Geoscience Institute, Salt Lake City.  
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# Books That Shaped Geology

When we look at the history of geology, we note that a number of books played tremendous roles in the transformation of our science. Some of these books, notably those by Georgius Agricola, Nicholas Steno, Carl Linnaeus, Comte de Buffon, Jean-Baptiste Lamarck, and Baron Georges Cuvier were published (in Latin or French) even before the term “geology” emerged in the late 18<sup>th</sup> century. But some others books, selected and introduced in this article, were published in the 19<sup>th</sup> and 20<sup>th</sup> centuries, chronicle the milestones in the development of geology, and are accessible to the modern reader. They have educational value as well, and one of them (by Sir Charley Lyell) was indeed a mainstream textbook in the 19<sup>th</sup> century (see “Changing Face of Geology Textbooks” in *TPG*, Q4, 2021).

Both geologists and geology students can benefit from reading the great classic books that shaped the science of geology. These readings have several benefits: (1) Critical understanding: The classics introduce us to some of the great minds who founded geology – how they thought, analyzed, and viewed Earth. (2) Historical understanding: They enrich our understanding of how geology evolved. (3) Writing skills: They teach us the art of writing and expressing research results to people and other scientists. Consider, for instance, the following paragraph from Charles Darwin's *Origin of the Species*: “From the first dawn of life, all organic beings are found to resemble each other in descending degrees, so that they can be classified in groups under groups. This classification is evidently not arbitrary like the grouping of the stars in constellations.” With these captivating images, Darwin proceeds to discuss the process of evolution of life forms by natural selection.

The following selection of the classic books in geology is limited to those written in or translated into English. Many of these books are out of print, but they are available in free e-books online in Google Books ([books.google.com](https://books.google.com)), Internet Archive ([archive.org](https://archive.org)), and Gutenberg Project ([www.gutenberg.org](https://www.gutenberg.org)).

“Both geologists and geology students can benefit from reading the great classic books that shaped the science of geology.”

## *Theory of the Earth and Illustrations of the Huttonian Theory of the Earth*

The Scottish scientist James Hutton (1726-1797) was one of the founding fathers of geology. His 1795 book *Theory of Earth, with Proofs and Illustrations* is regarded as the cornerstone of geology as it developed the idea of the antiquity of Earth (in contrast to James Ussher's Biblical young earth), uniformitarianism (in contrast to Georges Cuvier's catastrophism), and plutonism (in contrast to Abraham Werner's neptunism). These were among the major debates of that time. The Biblical Earth, according to Ussher, was created 4004 BC; while Hutton argued that “we find no vestige of a beginning, no prospect of an end.” Hutton introduced the revolutionary concept of Deep Time. Catastrophism, developed on the basis of fossils of extinct animals and global flood myths, divided Earth's history into epochs, each ending with a catastrophe. In contrast, Hutton's uniformitarianism argued that the same processes operating today have shaped Earth's history and geologic changes in a continuous fashion (Archibald Geikie later formatted this view as “the present is the key to the past”). Neptunism believed that primary (igneous) rocks precipitated from a primordial ocean (much like limestone); Plutonism (or vulcanism), on the other hand, suggested crystallization of granite and basalt from a hot magma as evident from volcanic eruptions. Hutton first published his ideas in a 30-page paper read before the Royal Society of Edinburgh in 1785, which later appeared in the *Transactions of the Royal Society of Edinburgh* (1788, volume 1, part 2, pp. 41-86) entitled “Theory of the Earth, or an Investigation of the Laws observable in the Composition, Dissolution, and Restoration of Land upon the Globe.” This paper formed the first chapter of Hutton's 1795 two-volume book, *Theory of the Earth*. (A third volume was published in 1899 edited by Sir Archibald Geikie.) Despite its importance, Hutton's book drew little attention and acceptance both because of criticism from his rival scientists and the difficult style of his prose. Stephen Gould in *Time's Arrow, Time's Cycle* (1987) remarked that Hutton was a “lousy writer.” In 1802, John Playfair (1747-1819) popularized Hutton's book in a manageable and readable version entitled *Illustrations of the Huttonian Theory of the Earth*. Today, both Hutton's and Playfair's books sound archaic. For instance, what they wrote “foffil” is “fossil” in the original meaning of the word – “something dug up,” including both fossils and minerals. They used “Vein” to mean both mineral vein and igneous dike. Nevertheless, Playfair's *Illustrations* is still the best way to approach Hutton's ideas. The book has been reprinted three



times – by the University of Illinois (1956), Dover (1964), and Cambridge University Press (2011).

## Principles of Geology

Charles Lyell, born in 1797 (the year Hutton died), is often regarded as Hutton's intellectual successor. Lyell's most celebrated book is *Principles of Geology*, first published in three volumes in 1830-1833. It was the mainstream geology textbook in the 19<sup>th</sup> century and trained generations of geologists, including Charles Darwin. The twelfth edition of the book in two volumes was published in October 1875, eight months after Lyell's death. *Principles of Geology* was subtitled "Being an Attempt to Explain the Former Changes of the Earth's Surface, by Reference to Causes Now in Operation."

Hutton and Lyell championed uniformitarianism with an emphasis on "gradualism" – that geologic changes, even though brought about by processes observable today, occur at very slow, continuous rates over long periods of time. Today, gradualism is not much favored by geologists because rates of geologic changes vary from very slow and long-term rates to, at times, rapid, short-lived, intense (or even catastrophic) phenomena. "Actualism" is sometimes used to express "process uniformitarianism" (in contrast to uniformitarianism of rate).

The first edition of Lyell's *Principles of Geology* in three volumes have been republished by the University of Chicago Press (1990), and an abridged version in a single volume (edited with an introduction by James Secord) has been published in Penguin Classics (1997).

## Cosmos

Alexander von Humboldt (1769-1859) is sometimes called the "last man who knew everything." He was a polymath who traveled worldwide, studied all branches of natural science, wrote a great number of books, and contributed to various fields, including geology. After spending his wealth on publishing his scientific works, in 1827 Humboldt was summoned by Friedrich Wilhelm III to Berlin. There Humboldt became a tutor to the crown prince and also began delivering a series of lectures on physical geography at the University of Berlin. These lectures held in a large hall proved to be extremely popular and were attended by many people. In the last three decades of his life in Berlin, Humboldt expanded his lectures to a five-volume book called *Kosmos, Entwurf einer physischen Weltbeschreibung*, published in Stuttgart from 1845-1862. The book became hugely popular, was translated into several languages, and sold in hundreds of thousands of copies. Two English translations, *Cosmos: A Sketch of a Physical Description of the Universe*, were made, both by women – by Elizabeth Leves Sabine (four volumes, 1846-1858), and by Elise Otté (five volumes, 1849-1858). American writers and poets like Edgar Allan Poe, Walt Whitman, Ralph Waldo Emerson were fond of reading the *Cosmos*. The title of the book refers to the ancient Greek idea that nature is a harmonious system, and indeed in the first volume of the book Humboldt remarks that "the most important aim of all physical science is this: to recognize unity in diversity." Today, Humboldt's *Cosmos* is a valuable reference book on physical sciences of the 18<sup>th</sup> and 19<sup>th</sup> centuries. In writing this book, Humboldt relied on not only his own work but also on the research and thoughts of a large number of scientists. The popularity of Humboldt's book is akin to that of Carl Sagan's *Cosmos* (PBS television series and companion book), whose very title also follows Humboldt's work. A modern edition of Humboldt's *Kosmos*

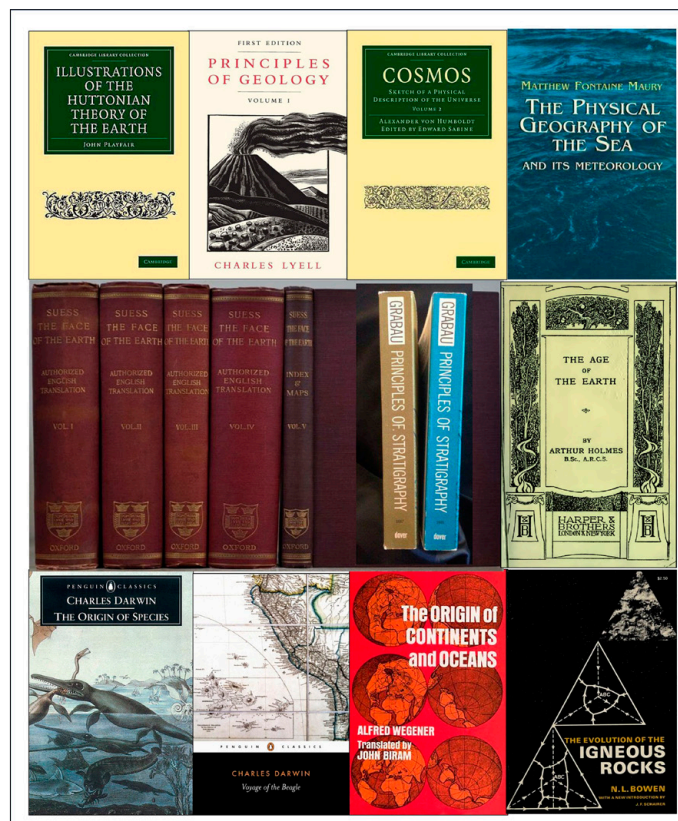
was published in Germany in 2004. The English translation by Elizabeth Leves Sabine (edited by her husband Edward Sabine) has been reprinted by the Cambridge University Press in 2010.

## The Physical Geography of the Sea

Matthew Fontaine Murray (1806-1873) was an American explorer and scientist. A devout Christian, he was encouraged to explore the oceans after reading Psalm 8:8 about "the paths of the seas." He served as the superintendent of the US Naval Observatory and the head of the Depot of Charts and Instruments, and studied the ocean basins, waters, currents, winds, and navigation routes, mapping, and weather systems. His book *The Physical Geography of the Sea* published by Harper & Brothers in New York is regarded as the first book on oceanography and marine geology. It was first published in 1855 with 287 pages and went through eight editions by 1861 with 485 pages.

## On the Origin of the Species

In 2005, Barnes&Noble published the entire works of Charles Darwin in one volume entitled *The Darwin Compendium*. It included *The Voyage of the Beagle* (1839), *On the Origin of the Species* (1859), *The Descent of Man and Selection in Relation to Sex* (1871), *The Expression of the Emotions in Man and Animals* (1872), and *The Autobiography of Charles Darwin* (1876). In the same year, W.W. Norton also published a similar collection volume of Darwin's books (excluding his autobiography): *From So Simple Beginning: Darwin's Four Great Books*, with an introduction by Edward O. Wilson. The occasion for these publications was the 150<sup>th</sup> anniversary of the *HMS Beagle* voyage completed in 1836 when the 27-year-old Darwin returned home after five years of exploration. I bought the Barnes&Noble edition (1874 pages, \$29.95) and



began reading it, on and off, for the following five years or so. Darwin's prose and style of writing provide excellent examples for science writing courses.

Charles Darwin (1809-1882) was undoubtedly one of the greatest natural scientists of all time. He is also one of the most researched and biographed scientists. Amazingly many of his books are still in print and still pleasantly readable. There are several modern prints of *The Origin of the Species* including the Penguin Classics (1982), Signet edition (mass-market low-cost print, 2003), and the 2003 Everyman's Library print (150<sup>th</sup> anniversary edition) which includes both *The Origin of the Species* and *The Voyage of the Beagle* (with an introduction by Richard Dawkins).

### **The Face of the Earth**

The Austrian geologist Eduard Suess (1831-1914) is a little-known figure to geologists, let alone students. I remember once talking to a colleague about Suess and remarked that he was a master of global tectonics. Not knowing about Suess, my colleague suggested that the university should invite him for a lecture! Suess was a pioneer of Alpine tectonics and a great scholar of geologic literature of his time. From 1885 to 1900 he worked on his magnum opus *Das Antlitz der Erde*, which was published in three volumes by Tempsky in Vienna. The book synthesized the global tectonics from studies in the 19<sup>th</sup> century. Although Suess was a pre-"continental drift" geologist, he developed such important concepts as Tethys, Gondwanaland, and Laurasia which were later incorporated by Alfred Wegener and others in the theories of continental drift and plate tectonics. Suess's book was translated into French (*La face de la terre*, three volumes) by Emmanuel de Margerie (Paris, 1897-1918) and into English (*The Face of the Earth*, five volumes) by Hertha B.C. Sollas (Clarendon Press, Oxford, 1904-1909 with the index as the fifth volume in 1924).

### **The Origin of Continents and Oceans**

The German scientist Alfred Wegener (1880-1930) is a familiar name to geology students: He developed the theory of continental drift (mostly based on evidence from continents), which later became plate tectonics after the discoveries of mid-ocean ridges, fracture (transfer fault) zones, and subduction zones on the ocean floor in the 1950s-60s. Wegener was a meteorologist and married the daughter of his teacher Wladimir Köppen, another climatologist. He led four expeditions to Greenland, the last of which took his life. By studying the past climates recorded in sedimentary rocks and fossils, Wegener suggested that there was a single global continent (Pangaea) in the Permian that was later fragmented and drifted apart to form the present continents. He called his hypothesis "Kontinental verschiebung" (continental drift) and discussed it first in a 1912 paper, and later in his book *Die Entstehung der Kontinente und Ozeane*. The book was published in 1915 with a fourth edition in 1929. The book has been translated into English twice: The third edition by J.G.K. Skerl in 1924 (Methuen, London) and the fourth edition by John Biram in 1966 (Dover, New York). Both translations are entitled *The Origin of Continents and Oceans*. Biram's translation is still in print.

### **Principles of Stratigraphy**

In geology textbooks and classes, we trace the principles of stratigraphy to Nicolas Steno, William Smith, and Charles Lyell. However, there were important links between those pioneering geologists and present-day status of geology. *Principles*

of *Stratigraphy*, published in 1913 and 1924 (revised edition, A.G. Seiler & Co., New York), by Amadeus William Grabau (1870-1946) is an important work that was used as an advanced textbook in stratigraphy in universities in North America and the UK. Grabau, born in Wisconsin to a family of Lutheran German immigrants, was an eminent American geologist. He was educated at MIT and Harvard, published major works in paleontology, taught at Columbia for two decades, and finally worked in China from 1920 until his death in 1946. He believed in "rhythmic" history of large-scale geologic events, such as mountain building episodes. Although he promoted the idea of geosynclines (a concept that was discredited after the advent of plate tectonics in the 1960s-70s), *Principles of Geology* offers analytic and integrative knowledge of formation and depositional environments of sedimentary rocks, sea-level changes, and stratigraphic record with scholarly references at the end of each chapter. The book was reprinted in two volumes by Dover in 1960 with an introduction by Marshall Kay. Many of Grabau's interpretations and ideas were later utilized in sequence stratigraphy.

### **The Evolution of the Igneous Rocks**

The Canadian geologist Norman Levi Bowen (1887-1956) is a household name. Every geologist is familiar with the concept of Bowen's reaction series – the sequential formation (fractional crystallization) of minerals from olivine through quartz from the hot molten magma as it ascends and cools. Bowen revolutionized experimental petrology and his contributions are described in his (now classic) work *The Evolution of the Igneous Rocks* (Princeton University Press, 1928). What is interesting about its title is that it used the term "evolution" (used before for organic evolution) for the development of minerals, for which terms like "formation" or "genesis" were previously used. *The Evolution of the Igneous Rocks* was reprinted by Dover Publications in 1960 with an introduction by J. F. Schairer, who also lists a bibliography of Bowen's papers.

### **The Age of the Earth**

Geochronology by radioactive methods rapidly developed in the 20<sup>th</sup> century after discoveries of radioactive elements, progress in nuclear physics, and development of mass spectrometry. Initially, physicists championed this field, but in 1911 one geology student, Arthur Holmes (1890-1965) became interested in the application of radiometric dating techniques to rocks. As a graduate student at Robert J. Strutt's lab at Imperial College, Holmes dated a rock sample from Ceylon by the U-Pb method to be 1.6 billion years old – the oldest rock known at that time. Holmes pioneered isotope geochronology, and in 1913, at age 27, he wrote the discipline's first book *The Age of the Earth* (Harper & Brothers, New York and London). A second edition in 1927 and a third edition in 1937 was published by Nelson in London. The book chronicles the development of radioactive dating from the pen of one of its founders. Holmes continued his work in the field, dated even older rocks, calculated an age of 4.5 billion years for the Earth based on the relative abundances of uranium isotopes, and introduced numerical ages to the geologic time scale. In 1960 he published the "revised geologic time-scale" (*Transactions of the Edinburgh Geological Society*, volume 17, pp. 183-216) which was used in geology textbooks for years.

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Science books, unlike novels, need not to be read from cover to cover. For that matter, very few scientists ever read



the classics in their own fields. How can we use the classic geology books in our education? This can be done on several levels. At the minimum, these books can be introduced to students: Who wrote them and why they are important in the development of geology. Selected chapters from the books can be given as reading assignments. These chapters should be interesting, informative, and appropriate to the course.

### *Old and New Paths, continued from p.43*

contributions to these lands. We also wanted to acknowledge that we had missed gathering their voices and stories in our past projects and events and want to include them in the future. This pathway forward was important to our attendees, speakers, and sponsors who work with the first peoples of this area.

It may be hard to read all the words in the slide. The slide states "The geoscience work we do in Wisconsin and Minnesota takes place on lands that were originally Native American homelands. We acknowledge that AIPG is hosting this meeting and field trips on the lands of the oθaakiiwaki·hina·ki (Sauk) & Meškwahki aša·hina (Fox), and Očhéthi Šakówinj (Dakota). Just to the east of our location across the Mississippi River, many of us traveled through the homelands of the Hoocąk (Ho-Chunk). We realize that we have been largely missing Tribal voices and knowledge of cultural history as we make decisions on the use of the land and its resources.

Our work does not start and end with a land acknowledgement. It is just one important action we will continue as geoscientists as we intentionally incorporate the knowledge and needs of Tribal nations in our work."

## New Sponsorships

Our second new path forward was addressing the transportation and refreshment costs that continue to rise. This event offered several new sponsorships that were of interest to our AIPG partners and members.

Motor coaches were provided for field trips that went hundreds of miles. The motor coaches had monitors above the seats that offered us an additional educational and funding opportunity.

A motor coach sponsorship for \$500 provided a method for the sponsor to video tape geoscience project(s) they wanted to share with event attendees. Then the videos were played on the field trip motor coaches and uploaded to the Section Facebook pages.

Lunch box sticker sponsorships for \$250 provided a method for companies to advertise their company name, logo, and webpage location.

School buses were provided for shorter field trips. We offered a school bus and a boat cruise sponsorship for \$250. These sponsors were provided advertising of their company logo on sandwich boards in front of the bus and boat loading areas.

## Agate Raffle for Student Poster Session

Our third new path helped us network with our student attendees. We encouraged our event participants to attend and learn from the student poster presentations by offering them an agate raffle!

Geology major students who are researching a particular topic can compare the state of knowledge of that particular topic described in the classic books with our current state of knowledge. This would provide an evolutionary perspective on a particular subject. Finally, the geology classics can be subjects of detailed research and analysis for dissertations in the history of science programs.

We created a questionnaire entitled "What did you learn" and asked the event attendees to visit each poster, fill in what they learned, and then return the bottom of the form to enter the raffle for the agates.

Two dozen raffle forms were returned and then shared with all the student poster presenters. The students appreciated all the extra attention and feedback.



Agate Raffle display by Christine Lilek.

## Keeping in Touch with Invited Attendees

Our final new path was a way for us to keep in contact with all our invited attendees. We created a LinkedIn event page that welcomed geologists and guests to a "once in a lifetime opportunity!" It invited them to learn about geology and remediation in SW WI and SE MN during the daytime and then sample Oktoberfest Beer, Music, and Dancing at night! We had over 1,600 people join our page to watch the development of the event.

<https://www.linkedin.com/events/6967178458678407168/comments/>

For more details and photos of the MN/WI AIPG Geology Weekend, please see WI AIPG's Winter 2023 Newsletter.

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